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AMERICAN FISHERIES SOCIETY.

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TRANSACTIONS

OF THE

AMERICAN

FISHERIES SOCIETY.

TWENTY-FIRST ANNUAL MEETING.

HELD IN THE HOLLAND HOUSE, N. Y. CITY.

MAY 25TH, 1892.

NEW YORK:
D. S. WALTON & CO., PRINTERS.
132 FRANKLIN STREET.
1892.

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Vice-President, FRED. MATHER...*Cold Spring Harbor, N. Y.*
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W. H. BOWMAN.....*Rochester, N. Y.*
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N. K. FAIRBANKS.....*Chicago, Ill.*
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B. P. PORTER.....*San Francisco, Cal.*

Local Committee.

WM. L. MAY.....*Omaha, Neb.*
CALVERT SPENSLEY.....*Mineral Point, Wis.*
WM. A. BUTLER, Jr.....*Detroit, Mich.*
J. E. GUNCKEL.....*Toledo, O.*
S. P. BARTLETT.....*Quincy, Ill.*

MINUTES

OF THE

TWENTY-FIRST ANNUAL MEETING

OF THE

AMERICAN FISHERIES SOCIETY,

HELD IN THE

CITY OF NEW YORK,

WEDNESDAY, MAY 25TH, 1892,

AT THE HOLLAND HOUSE.

PART FIRST.

THE FOLLOWING MEMBERS WERE PRESENT:

F. J. Amsden,	Rochester, N. Y.
L. D. Huntington,	New Rochelle, N. Y.
Dr. Tarleton H. Bean,	Washington, D. C.
James Benkard,	New York City.
Prof. A. S. Bickmore,	New York City.
Henry Burden,	Troy, N. Y.
W. A. Butler, Jr.,	Detroit, Mich.
Dr. H. H. Carey,	Atlanta, Ga.
Frank N. Clark,	Northville, Mich.
William A. Conklin,	New York City

Fred Mather, - - Cold Spring Harbor, N. Y.
E. P. Doyle, - - - New York City.
J. F. Ellis, - - - Washington, D. C.
N. K. Fairbank, - - - - Chicago, Ill.
Henry C. Ford, - - - - Bay City, Mich.
Asa B. French, - - South Braintree, Mass.
John Gay, - - - Washington, D. C.
W. L. Gilbert, - - - Plymouth, Mass.
G. Brown Goode, - - Washington, D. C.
J. E. Gunckel, - - - - Toledo, O.
Charles F. Imbrie, - - - New York City.
Dr. Bushrod W. James, - - Philadelphia, Pa.
W. L. May, - - - - Omaha, Neb.
Col. M. McDonald, - - - Washington, D. C.
W. F. Page, - - - Washington, D. C.
Dr. J. C. Parker, - - - Grand Rapids, Mich.
Hoyt Post, - - - - Detroit, Mich.
W. L. Powell, - - - Harrisburg, Pa.
R. Redmond, - - - - New York City.
Chas. B. Reynolds, - - - New York City.
Hon. Geo. M. Robeson, - - Camden, N. J.
William P. Seal, - - - Washington, D. C.
L. Streuber, - - - - - Erie, Pa.
Herschel Whitaker, - - - Detroit, Mich.
J. D. Quackenbos, - - - New York City.
W. S. Webb, - - - - New York City.
John H. Titcomb, - - - Rutland, Vt.
C. C. Warren, - - - Waterbury, Conn.
W. H. Rogers, - - - - Amherst, N. S.
Daniel Morrell, - - - Hartford, Conn.
Chas. F. Orvis, - - - - Manchester, Vt.
J. F. Merrill, Ph. D., - - Albany, N. Y.
Dr. E. Bradley, - - - New York City.
J. W. B. Hughes, - - - New York City.
J. W. Hoxie, - - - - Carolina, R. I.
W. H. Bowman, - - - Rochester, N. Y.
Charles F. Chamberlayne. - Buzzard's Bay, Mass.
David G. Hackney, - - - Fort Plain, N. Y.

In the absence of Dr. James A. Henshall, President of the Society, Dr. James C. Parker, Vice-President, presided.

Letters of regret at their inability to attend were read from J. C. Bottemantle of Holland; Dr. James A. Henshall, Washington, D. C.; Hon. E. D. Potter, Toledo, O.; A. Nelson Cheney, Glens Falls, N. Y., and C. Zweighaft, Philadelphia, Pa.

The secretary read a communication from the New York Society for the Protection of Fish and Game, requesting the presence of the members at a dinner to be given at the Holland House, Wednesday evening, May 25th, and on motion the invitation was accepted and the secretary directed to express to the President of the Society for the Protection of Fish and Game the thanks of the American Fisheries Society.

The secretary also read an invitation from Mr. Roland Redmond, President of the South Side Club, to visit the preserves of the Club on Long Island on Thursday, May 26th, members to go by special train leaving Long Island City at 9.30 in the morning.

On motion, the invitation was accepted, and the secretary was directed to write to the President of the South Side Club thanking him for his courtesy.

Mr. Henry C. Ford of Philadelphia, Pa., then presented his annual report as Treasurer of the Association. The report is as follows:

AMERICAN FISHERIES SOCIETY
IN ACCOUNT WITH
HENRY C. FORD, Treasurer.

1891.	CREDITS.	DEBITS.	CREDITS.
May 26.	By cash, balance on hand...		$ 98.87
1892.			
May 24.	" Members' dues, received.....		324.00
			$422.87

DEBITS.

1891.			
May 28.	To cash paid time of omnibus at Washington....	$ 7.00	
June 15.	To cash Spangler & Davis, printing bills.....	1.00	
July 30.	To cash Mary Walling, type-writing report.....	4.75	
" 30.	To cash Photo-Engraving Co.....	7.00	
" 30.	To cash 100 stamped envelopes.....	2.16	
Aug. 8.	To cash E. P. Doyle, new circulars.....	9.16	
" 12.	To cash expressage on circulars to Philadelphia..	1.00	
" 12.	To cash expressage on circulars to Egypt Hills..	.80	
" 12.	To cash 100 stamped envelopes....	2.16	
" 12.	To cash John M. Davis, printing report.....	124.20	
" 31.	To cash E. P. Doyle, sundry expenses.....	22.75	
Sept. 3.	To cash stamped envelopes.	2.16	
1892.			
Jan. 29.	To cash E. P. Doyle, sending out circulars.....	15.00	
" 30.	To cash F. Richardson, sending out circulars....	6.00	
May 24.	To cash balance on hand..	217.73	
		$422.87	$422.87

Philadelphia, May 24th, 1892.

E. O. E. H. C. FORD.

On motion of Dr. Carey of Georgia, the report was referred to a Committee of Three, consisting of H. H.

Carey of Georgia, Hoyt Post of Michigan, and F. J. Amsden of New York, for audit.

The secretary then presented the report for the past year. The report was received and ordered filed. It is as follows:

May 25th, 1892.

To the President and Members of the American Fisheries Society.

Gentlemen:

I have to report that during the year past 4 members of the society have died, 4 resigned, and 43 new members elected. The present membership is:

Corresponding,	27
Honorary,	6
Active,	220

The committee appointed at the last meeting to endeavor to increase the membership of the society have done a great deal of work, but the results have been rather meagre. Circulars were sent to hundreds of sportsmen throughout the country, but only about thirty responded. The only way in which the membership can be materially increased is by the personal solicitation of our members. I would urge that each member feel himself specially charged with securing as many new members as possible, so that the society may make a good showing at Chicago in 1893.

Many of the new members obtained this year were obtained through the efforts of Mr. Cheney, and much credit is due him for his work.

The society is in a more prosperous condition than ever before, and there is no reason why its ultimate success as a powerful and influential organization should not be assured.

Very respectfully,

EDWARD P. DOYLE,

Secretary.

Mr. W. L. May of Nebraska, moved that a Commit-

tee of Three be appointed to nominate officers for the society for the ensuing year.

The motion was carried, and the president appointed as such committee, W. L. May of Nebraska; H. H. Carey of Georgia, and William A. Butler, Jr., of Michigan.

The reading of papers then began and continued until adjournment, which was taken until 2 o'clock of the same day.

Minutes of adjourned meeting: Meeting called to order at 2.15 o'clock.

Mr. May, from the committee appointed for the purpose, reported the following nominations for officers for the society for the ensuing year. The report is as follows:

To the Officers and Members of the
American Fisheries Society:

Your committee appointed to nominate officers for the ensuing year, respectfully recommend that the following be elected to fill the respective offices for which they are named:

President, Herschel Whitaker, Detroit, Mich.
Vice-President, Fred. Mather, Cold Spring Harbor, N. Y.
Treasurer, Henry C. Ford, Philadelphia, Pa.
Rec. Secretary, E. P. Doyle, New York City.
Cor. Secretary, Tarleton H. Bean, Washington, D. C.
Executive Committee,
H. H. Carey, La Grange, Ga
William H. Bowman, Rochester, N. Y.
L. Streuber, Erie, Pa.
William M. Hudson, Hartford, Conn.
N. K. Fairbank, Chicago, Ill.
C. V. Osborn, Dayton, O.
B. P. Porter, San Francisco, Cal.

W. L. May,
Wm. A. Butler, Jr., } *Committee.*
H. H. Carey,

On motion, and by unanimous consent, the report of the committee was adopted and the officers named elected

The question of the selection of a place for the next meeting of the society was then brought up, and on motion it was unanimously decided to hold the next meeting of the society in Chicago, on the second Wednesday of August, 1893.

The secretary read an invitation from J. W. Collins, Chief of the Department of Fish and Fisheries at the World's Fair, tendering the use of the Fisheries Building for the meeting of the society.

He also read an invitation from the Michigan World's Fair Commissioners, tendering the use of the Michigan Building for the same purpose.

On motion, it was ordered that the invitations be referred to the Committee on Local Entertainment when appointed, and that the secretary acknowledge their receipt.

Mr. May then moved that a Committee of Five on Local Entertainment be appointed from the States nearest Chicago.

Motion was carried, and the committee was appointed as follows:

Wm. L. May, Omaha, Neb.
Calvert Spensley, Mineral Point, Wis.
Wm. A Butler, Jr., Detroit, Mich.
J. E. Gunckel, Toledo, O.
S. P. Bartlett, Quincy, Ill.

Mr. Hoyt Post of Michigan, moved the following resolution:

"*Resolved*, That this society regards with disfavor any "movement looking towards the turning over to the "United States Government the work of the said com- "missions in propagating and planting fish and in the "regulation and protection of the fisheries in the several "States. That the jurisdiction over fisheries within the

"territorial boundaries of each State belongs naturally to "that State, That there is an abundant field for the co- "operative action of the State, and of the general gov- "ernment in the propagation and distribution of food "and game fish and anything which would detract from "the State's interest in this respect will be detrimental "to the end aimed at of restocking the waters of this "country, and we recommend a course which will "encourage and stimulate greater interest and larger "expenditures in this great work by the several States, "and at the same time increased interest in the matter by "the United States. And be it further

"*Resolved*, That the purposes and aims of this society "are in direct antagonism with any business which tends "to the depopulation of the waters to enrich the land, "we therefore condemn purse seining of menhaden or "of any fish food or food fish for the purpose of grind "ing the same into guano or oil."

A division of the question was asked for, and the first resolution was adopted and the second laid on the table until the next meeting.

Mr. James Benkard moved the appointment of a committee to prepare resolutions expressing the grief of the society at the sudden death of ex-President George Shepard Page.

The committee appointed was as follows:

James Benkard, Fred, Mather, W. L. May.

The following named gentlemen were then unanimously elected active members of the society:

Archibald Mitchell,	Norwich, Conn.
E. W. Leavenworth,	Wilkesbarre, Pa.
Geo. T. Mills,	Carson City, Nev.
A. G. Hall,	Reeds Creek, N. Y.
W. S. Gavitt,	Lyons, N. Y.
T. E. Krumbholtz,	Wawbeek, N. Y.
Saranac Lake Hotel Co.,	Saranac Inn, N. Y.
Witherbee W. C.,	Port Henry, N. Y.

F. J. Anderson, - - - Whitestone, N. Y.
B. F. Van Valkenburg, - - New York City.
A. Booth Packing Co., - - - Chicago, Ill.
S. Zweighaft, - - - Philadelphia, Pa.
R. W. Jones, - - - - Syracuse, N. Y.
G. S. Klock, - - - - Rome, N. Y.
Henry G. Preston, - - - Brooklyn, N Y.
J. D. Quackenbos, - - Columbia College, N. Y.
W. S. Webb, - - - - New York City.
John N. Titcomb, - - - - Rutland, Vt.
Joseph O. Miller, - - - Mt. Kisco, N. Y.
Edward F. Brush, M. D., - - Mount Vernon, N. Y.
C. C. Warren, - - - - Waterbury, Vt.
E. W. Adams, - - - 110 Wall St., N. Y.
James Yalden, - - - - 11 Pine St., N. Y.
Geo. W. Upston, - - - Warren, Ohio.
J. A. Powers, - - - Lansingburg, N. Y.
J. H. Offensend, - - - Fair Haven, Vt.
F. W. Ayers, - - - - Bangor, Me.
W. H. Rogers, - - Amherst, Nova Scotia.
Alex. Taylor, Jr., - - Mamaroneck, N. Y.
Jas. A. Greuseback, - - New Rochelle, N. Y.
John Q. Underhill, - - New Rochelle, N. Y.
Daniel Morrell, - - - Hartford, Conn.
E. G. Whitaker, - - - New York City.
Chas. F. Orvis, - - - Manchester, Vt.
Robert Lenox Banks, - - - Albany, N. Y.
T. H. Foulds, M. D., - - Glens Falls, N. Y.
H. S. Buell, - - - - Albany, N. Y.
F. J. Merrill, Ph D., - - Albany, N. Y.
E. Bradley, M. D. - - - New York City.
D. W. B. Hughes, - - - New York City.
Samuel Garman, - - - Cambridge, Mass.
Heber Bishop, M. D., - - Boston. Mass.
J. W. Hoxie, - - - - Carolina, R. I.
W. H. Bowman, - - - Rochester, N. Y.
Chas. F. Chamberlayne. - - Buzzards Bay, Mass.
David G. Hackney, - - Fort Plain, N. Y.

Fred Mather,	Cold Spring Harbor, N. Y.
Robert Hamilton,	Greenwich. N. Y.
Wm. F. Balkam,	Rochester, N. Y.
Dr. Bushrod W. James,	Philadelphia, Pa.

On the proposition of G. Brown Goode, Dr. Decio Vinciguerra, University of Rome, Italy, was elected a corresponding member.

On the proposition of Mr. A. R. Cheney, Mr. Thomas Andrews, Westgate House, Guilford, England, was elected a corresponding member of the society.

The reading of papers then continued until adjournment.

The titles of the papers read during the entire session, morning and afternoon, were as follows:

"Fish and Fishing in Ohio," J. E. Gunckel, Toledo.

"Planting Fry *vs.* Planting Fingerlings," James Nevins, Madison, Wis.

"Food for Fishes," A. N. Cheney, Glens Falls, N. Y.

"The Present Status of Trout Culture," William P. Seal, Washington, D. C.

"American Salmon and Other Food Fishes," Dr. Bushrod W. James, Philadelphia, Pa.

"Feeding Trout Fry," Fred Mather, Cold Spring Harbor, N. Y.

"The Susquehanna; Past, Present and Future," A. F. Clapp, Sunbury, Pa.

"Rearing Trout for Distribution," Frank N. Clark, Northville, Mich.

"Fry *vs.* Fingerlings," Herschel Whitaker, Detroit, Mich.

"The Past and Future of Fishculture; Or, a Historical Glance at the Cultivation of the Waters," M. Raveret Wattel, Paris, France.

"Historical Review of the Fisheries of the Great Lakes," Herschel Whitaker, Detroit, Mich.

"State Control of State Fisheries," Hoyt Post, Detroit, Mich.

"Artificially Reared Trout," W. L. Gilbert, Plymouth, Mass.

"National Salmon Park," Livingston Stone, Charlestown, N. H.

"Fish-ways," W. H. Rogers, Amherst, N. S.

"The Eggs of the Rainbow Trout," W. F. Page, Neosho, Mo.

"Naturalization of Fisheries," Chas. F. Chamberlayne, Buzzards Bay, Mass.

These papers and the discussion they excited will be found in full in part two of the proceedings.

Minutes of an adjourned meeting of the American Fisheries Society, held in the parlors of the South Side Club, Oakdale, Long Island, Thursday, May 26th, 1892. Meeting called to order at 11 o'clock.

On the proposition of W. F. Page, Mr. E. Chazari, No. 11 Arco de San Augustine, City of Mexico, was elected a corresponding member of the society.

Upon motion of Mr. Hoyt Post, the following resolution was unanimously adopted:

"*Resolved*, That the several Fish Commissioners of "the United States be and hereby are by virtue of the "offices they hold, declared members of the American "Fisheries Society, And be it further

"*Resolved*, That the Secretary write to such Commis- "sioners at once, informing them of the aims of the "society, and request their acceptance of membership."

The resolution regarding purse nets laid on the table at the last meeting, then came up and after considerable discussion, participated in by Col. McDonald, Geo. M. Robeson, L. D. Huntington, Hoyt Post, Herschel

Whitaker and others, the resolution was amended and unanimously adopted.

The resolution as amended is as follows :

"*Resolved*, That the purposes and aims of this society "are in direct antagonism with any business which leads "to the depopulation of the waters to enrich the land "and we therefore condemn purse seining of menhadan "or any fish food or food fish for the purpose of grinding "the same into guano or oil, within three miles of the "shore at low water mark."

On motion and by unanimous consent, the secretary was directed to write the several fish commissioners of the United States, requesting that each board of commissioners delegate one of its number to prepare a historical review of the work of the respective commissions since their creation, to be read at the Twenty-second Annual Meeting of the society in Chicago, in 1893.

On motion, the following resolution was unanimously adopted :

"*Resolved*, That the thanks of the American Fisheries "Society are hereby extended to the New York Society "for the Protection of Fish and Game, for the entertain- "ment given the society, and to the South Side Club for "the courtesy extended at their club preserves on Long "Island. And be it further

"*Resolved*, That the thanks of the society be tendered "to the management of the Holland House for the use "of the rooms in which the meetings of the society have "been held, and for other courtesies extended. And be "it further

"*Resolved*, That the New York Society for the Pro- "tection of Fish and Game and the South Side Club be "made honorary members of this society."

Meeting then adjourned *sine die*.

EDWARD P. DOYLE,

Recording Secretary.

PAPERS READ BEFORE THE

American Fisheries Society,

WITH THEIR DISCUSSIONS,

MAY 25TH, 1892.

PART SECOND.

FISH AND FISHING IN OHIO.

By John E. Gunckel.

For 200 miles within the boundary lines of Ohio the blue waters of Lake Erie dash against rocky cliffs, mingle with tributary rivers or peacefully roll over long stretches of white sandy beach. This great open expanse in early days abounded in food fishes. The choicest were only selected of the now twenty species eagerly sought after. The few inhabitants found the supply more than sufficient for their needs; and indeed it seemed practicably inexhaustible. But as the population increased and industries became diversified, men gradually came to take fish to meet the demand of those living at a distance from the water, making what had hitherto been an occasional occupation, a regular means of livelihood—an industry. Here began the unequal struggle between the inhabitants of the land and water in which was foreseen the inevitable result of the virtual extinction of the weaker creatures. In addition to what then seemed to be wise legislation for the protection of fish, the science of fishculture came to the relief, and it was then seen

that man was to be used as an instrument to prevent the extinction of the species of food fishes in our inland waters. In the fall of 1875 the first governmental efforts were made to hatch whitefish. The parent fish were first obtained, the eggs extracted and fertilized, and it is a fact that almost every egg was safely hatched and the young deposited in the waters of Lake Erie. From that date to the present time the State, through its efficient Commission, has deposited in Lake Erie 400,000,000 of young whitefish. Since the spring of 1880 upward of 200,000,000 of pickerel have been hatched by the Commission, and deposited in Ohio waters suitable for them; and from the last official report, dated May 16, 1892, out of four hundred quarts of pickerel spawn sixty per cent. was hatched. Not only do people living along the lake shore find almost daily supply of food, fishes for consumption in a fresh state, but by proper methods of preparation and preservation the product of the lake is fitted for long continued keeping and transportation to distant markets where fishing is difficult, impracticable or impossible. With able legislation and increased assistance of the Fish Commissioners the supply of food fishes does not equal the demand, and the fisherman's cry, from shore to shore, is the scarcity of favorite fishes, and each year the perfected net appliances increase. Closer and closer are the spawning grounds limited, deeper and longer are the gill-nets and smaller the meshes until whitefish the size of herring are taken from the deepest waters. Back in the seventies sturgeon were so plentiful and useless that hundreds were daily thrown out of the nets back into the water. To-day nearly every part of the fish is utilized and the net fisherman is fortunate who captures four or five in his daily catch. Again the fishculturist is heard from and he introduces methods of artificial hatching, and it is estimated that 80 per cent. of the young sturgeon released in the waters live to take care of themselves—so hardy

and capable of self defense and self supporting are the fry. I have the pleasure of personally knowing many of Ohio's foremost fishculturists who have spent years in propagating fish, studying and becoming familiar with the habits and devising ways and means to check the rapid decrease and to replenish depleted waters. Many of the commercial fishermen appreciate and recognize their efforts, and while the fishermen are gradually covering, with killing nets, nearly all the territory where fish visit—for scarcity of fish means more twine—they cheerfully suggested plans and ideas to aid those who are so deeply interested in preserving our food fishes.

The following notes of interest I have gleaned from wholesale fishermen along the various lake ports. Of whitefish, ten out of sixteen fishermen believed that twelve per cent. of the fish deposited in the lake by the Commission were captured with gill nets before they reached one pound in weight in the deep water off the Pennsylvania shore. Twenty per cent. lived to maturity, and this could be increased fifteen per cent. more if the young fish were treated like we raise little pigs—deposited in pens in suitable water around the islands until old enough to take care of themselves In 1857, on the south shore of the lake, during almost every strong northeastern gale the spawn of whitefish was cast up on the beach in such immense quantities it was often strewn to the depth of 2 or 3in., several feet wide, for miles along the shore. The general complaint, although reluctantly admitted, is that the meshes of the rapidly increasing gill nets are too small, they are destroying whitefish weighing less than 1lb., while the leaders of the pound nets are increasing to such an alarming extent as to seriously interfere with navigation, let alone keeping back the fish en route to their spawning grounds. All fishermen agree that the natural spawning grounds of the lake are at the mouth of the Detroit River. Whitefish, pickerel, bass, saugers, sturgeon and other food fishes pay annual visits to this

point; the pickerel depositing their eggs as they pass up the river, paying no attention to hatching or caring for their young. Sturgeon are caught while rolling around their spawning beds, or guarding their young. The bed of the river and following the channel far into the lakes is literally alive with suckers of all sizes and kinds. There is no spot on the chain of lakes equal to this clear, rapid river for small-mouthed black bass and other game fish to spawn and thrive. The flavor of fish caught in this magnificent body of water is world known. It is also an admitted fact, and well known by the writer, that the channel in Sandusky Bay, winding, as it does, through a broad expanse of shallow water, is the best protected body of water along the lake shore, and while other bays and tributary rivers formerly abounded with the beautiful white bass and are now almost extinct, this channel leading up the Sandusky River is alive with this clean-looking fish from June until late in the fall; and further inland, among the bends and narrow channels lined with blooming lilies, can be found in great numbers the finest large-mouthed black bass grounds in the world. Referring to pickerel, bass and other food species, the majority of fishermen agree that all channels leading to and from the lake through the bays and rivers proper should be kept clear of nets particularly in the spawning seasons, for eventually the net fishermen must be actually benefited by allowing a large number of fish to cast their spawn in waters above the roving egg-destroying marauders, for as the country with its drainage toward the lake is being tilled to an extent beyond belief the creeks and rivers rise so rapidly and so high that fish are found in great quantities in ditches miles inland from the lake.

While the general public believe that unless some decided and effective measures are adopted to enable a large number of fish to safely reach their spawning grounds, there is great danger of extermination of our

lake food fishes; and while many of our commercial fishermen oppose protective legislation mainly because they object to any laws which shall limit their ability to take all the fish possible from a given water area in a given time, the thoughful fishermen express a willingness to co-operate with legislative enactments looking to thorough preservation of fish. My attention has been frequently called to the fact that there is no legislation on the statute books of Ohio which offers any protection to the game and food fish of Lake Erie during the spawning season. Any attempt at such legislation is met by the organized opposition of the men who wrongfully imagine that their private interests are thereby attacked, and who have been able thus far to prevent the passage of many measures that would have materially benefited them in the end. On the other hand, most men do not care to expend time and money in urging a species of legislation from which they are to reap only an indirect and remote advantage. Neither for the same reason do they incline to aid in securing a thorough and impartial enforcement of such laws as already exist. Many believe in restriction as to the seasons and methods of taking fish, but they are unwilling to act as either prosecutors or witnesses when such laws are violated. In this connection I might add that in all legislative action taken, whether by national or State governments, care should be taken to properly define what constitutes the waters of the lakes and inland waters. One of the most prolific causes of misunderstanding as to the meaning of various laws now passed has been the claim made by some that the waters of the lake extended up the rivers as far as tide water; it will thus be seen that the efforts to protect the rivers are paralyzed by having their mouths filled with nets. Another trouble is the lack of uniformity of the laws in adjoining States, thus in Ohio some of our best streams are fully protected against destructive net fishing, while their mouths, emptying into the lake in an

adjoining State, are completely blockaded with nets, the nets even extending from either shore across the channels. Uniformity would give a clearer comprehension as to the meaning of the law in both States.

Another serious difficulty in the enforcement of existing laws is that the officials to whom such enforcement is committed are left without fixed adequate compensation for their services. An Ohio fish warden receives no remuneration, and even his time and labor in securing an arrest and prosecution are wholly unremunerated unless he secures a conviction. We need most of all to educate the people into a broader and fuller appreciation not alone of the rights of others but of their own interests. We shall succeed in this work when we make the general public comprehend that in protecting the rights of others in the fish of our open waters we are in reality preserving our own, Relative to interior fish and fishing the subject is one of such vast interest that it would require another paper much longer than this to do it justice. It is generally believed that the laws are better observed than along the lake shore; that game fish are increasing and the people are in sympathy with the commission and appreciate their labors. With the Ohio State fish car, the Buckeye, the commission has deposited some twelve thousand black bass, weighing from a half to three pounds in the rivers and creeks throughout the State.

I could hardly close without a word about our rod and line fishermen. There seems to be implanted in the nature of every Buckeye angler the love of outdoor sport; they recognize fishing as the keenest of enjoyments. While it is the common destiny of mankind to labor from the cradle to the grave, toil and hardship are brightened by and often endured for, the prospect of angling, with its anticipated hopes, fears and pleasures. I can say from a personal experience that the desire to kill and destroy is more a potent motive, with our rod fishermen, than a necessity. It is a conceded fact that Ohio contains more

truthful anglers than any State in the Union the city of Toledo leading. I will relate an incident narrated recently to me by that venerable fisherman, Hon. Emery D. Potter, illustrating the pleasure of fishing with hook and line in Ohio, under favorable circumstances. "Among the many pleasant incidents of hook and line fishing," said the judge, "and one of the most successful afternoon outings I ever experienced, was in the year 1863, with Dr. Theodatus Garlick of Cleveland, Ohio. The doctor was a great hunter and frequented the marshes at the head of Lake Erie. One afternoon when hunting was poor I persuaded him to accompany me in a boat to try his luck at fishing. He accepted and we anchored in one of the many guts around Gard Island, and began casting for black bass. We fished thirty minutes and succeeded in landing thirty-two bass, the largest weighing four, the smallest two pounds. A fair afternoon's fishing. In reply to my question, to the doctor, the next day 'to go a-fishing,' he looked very serious and said, 'Well, judge, having no use for the fish I am honestly ashamed to fish for the fun of it.'"

FOOD FOR FISHES.

By A. Nelson Cheney.

As a rule fishermen give themselves little concern about the food supply of the fishes which they delight to capture with rod and reel, with fly and bait. If a trout as it is taken from the landing-net is found to be plump and well fed, the fact is noted as it is placed on a bed of ferns in the creel; and so, too, when a trout proves to be gaunt and lean its condition is commented upon, but not one angler in a hundred ever thinks of making the least effort to supply food which will enable the gaunt, lean fish to become plump and well fed.

Nearly ten years ago I prepared a paper upon the subject of Food Fish and Fish Food, which was read before this society. Since that time great strides forward have been made in all branches of the science of fishculture, and fishermen are reaping the benefits; but to-day, outside of fishcultural establishments, the subject of supplying the ever-increasing output of fish with an abundance and variety of food receives little if any more attention than it did then. This is a matter in which fishermen, if they are inclined, can render valuable aid to the hatcheries and fish-breeding establishments that are planting fish in public waters.

I am of the opinion that there may be many anglers throughout the land willing to render assistance in increasing the food supply of fishes in waters not within the direct influence of the National or State Fish Commissions, if they could know how to go about it, and at the same time know what a simple matter it is to furnish a diversity of food to fishes that from natural causes may be restricted in their diet. Primarily, I address the anglers, but the subject is so broad a one that in applying the suggestions that I shall make, others may be interested. As an example of stocking water with fish food not native to it, I may cite a lake in the State of New

York, which is thirty-six miles long and from one to two and one-half miles wide, that was planted with 18,000 crayfish in 1878. The plant was made in two or three streams at one end of the lake, and for several years past the crayfish have been found in abundance from one end to the other of the thirty-six miles of water. A form of fish food that I have been and am specially interested in is the fresh-water shrimp, *Gammarus fasciatus* of Say, or perhaps more frequently called *Gammarus pulex.* We have three species of *Gammarus* in our ponds, brooks and rivers, and Prof. S. I. Smith says of them: 'They probably breed throughout the spring and summer, as females taken at various times from March to August are found carrying eggs or young in various stages of development." He infers that, as species allied to the *fasciatus* develop rapidly, they breed several times each season. When trout are found to have dark-red flesh with cream-like curds between the flesh flakes, it is a sure sign that the waters they inhabit produce crustacean food in abundance.

I have transplanted shrimp in trout streams with the best results, but never have tried them in ponds. Caledonia Spring Creek. on which one of the hatching stations of the New York Fish Commission is situated, is famous the country over for its well-conditioned trout and its abundance of fish food. The Castalia stream in Ohio is similar in character to Caledonia Creek, and the fish food in many respects is identical because of transplanting mosses and water weeds with accompanying insect and crustacean forms of life from the latter to the former. Prof J. A. Lintner examined a can of mosses and aquatic plants sent to him from Caledonia Creek after "his attention had been called to the remarkable abundance of trout in the stream, abounding, it was believed, as in no other natural locality in the United States."

When the can was opened the mosses and plants swarmed with insect larvæ and crustaceans to such an

extent that he could not believe that it was a fair representation of the fauna of the creek, and wrote to know if other animal life than that which naturally accompanied the plants had not been placed in the can, but none had been introduced except those contained in the plant when gathered. Shrimp were so numerous in the moss that one could not raise a handful of it without noticing the very large number of these creatures present. The water from the can was poured into an aquarium and at once "numerous examples of the minute crustacean cyclops were observed, resting against its glass sides or darting swiftly through the water, the females bearing on each side of them the ovoid sac of eggs which forms so conspicuous a feature of their appearance."

Prof. Peck, the State Botanist, who examined the aquatic plants from Caledonia, said: "There is among the mosses one of special interest, both because of its rare occurrence and because of the noticeable coincidence between its abundant growth there and the abundance of animal life that accompanies it. * * * It is known to botanists by the name *Hypnum noteraphilum*, or moisture-loving moss. Franklin and Lancaster counties, Pennsylvania, are its previously reported localities, where it is said to grow in limestone springs. It was discovered in the Caledonia Creek several years ago * * * but up to the present time this remains its only known locality in our State." Prof. Peck advises that in transplanting this moss, limestone waters should be selected, although one of the mosses associated with it at Caledonia occurs in waters free from lime. Prof. Lintner says that the small crustaceæ of the family *Gammaridæ* undergo no metamorphoses after their escape from the egg, and therefore give promise of no difficulty in their propagation, and he thinks that in time every order for 5,000 brook trout will be accompanied with an order for 100,000 shrimps. The food of the shrimps is in doubt, "but they are believed to be principally vegetable feed-

ers, although eating animal matter in a decayed state when convenient to them." Again quoting from Prof. Lintner: "The ordinary laws of nature give us a prodigality of insect life almost infinitely in excess of fish fecundity. A fish deposits her spawn but once during the year, but in the aphis or plant louse in one year there may be twenty generations. Latreille says that a female aphis produces about twenty-five young each day, and Reaumur proved by experiment that a single aphis might be the progenitor of nearly six billion descendants during her life. The crustaceans are also remarkably prolific, * * * the proposition to propagate crustaceans and insects for fishculture must be regarded as intimately connected with that of transplantation—perhaps as a corollary of it."

Mr. Thomas Andrews of Guildford, England, a noted pisciculturist whose reputation as a successful fish propagator is broader than his native land, in writing me of some large fish in one of his ponds, said that they were grown in ponds containing an extraordinary amount of natural food, which he made a point of cultivating. I asked him to tell me what this food consisted of and his manner of rearing it, and he writes as follows:

"WESTGATE HOUSE, GUILDFORD, Eng.,
May 7, 1892.

"I make a great point of natural food for my trout, and devote several boxes of 10 or 12ft. long, 6ft. wide and 1ft. deep to that purpose, besides numerous small ponds and side streams. In order to appreciate the value of the principal, and I consider the best, food for young trout, viz., *Gammarus pulex*, one must observe them at this season of the year, and they will be found in pairs. If a pair is captured; the male insect detaches itself from the female, and she will look large on the abdomen and of an orange color. If she is placed in the palm of the hand and slightly pressed with a camel's hair pencil, the young will be squeezed from her. This is my food for young

fry! The young shrimp is just the size for a hungry trout seven weeks old, and I have often brought the *Gammarus* up from my ponds to the hatchery and fed them there. There are, of course, other insects which are very suitable for the young fish, and I cultivate largely the 'alder fly,' whose eggs are to be found on the rushes and grass hanging over the streams or ponds in May and June in England. I collect these eggs and hatch them out, turning the larvæ into the water. I need hardly tell you that they are almost microscopic, and just the thing for the young fish. Then there is the 'grannom fly,' which I cultivate by bringing home the eggs which are found in bunches, attached to rushes, bits of stick, grass and woodwork in the rivers. To-day I had a can of grannom eggs sent up, and I should think there is a bushel basketful of these. They will be sent down to my ponds on Monday and placed just as they are in among weeds and rushes and will hatch in due time. The May-fly we can and do introduce in the same way, but until last season they were put into a pond where there were about 15,000 yearlings, and they stood but little chance to increase. Last season the eggs of the May-fly had a place devoted to them, where there were no fish, and we have found quantities of larvæ already. We also cultivate the *Limniadæ* (snails), and the young of these make capital food for my fish of all ages. We feed the snails and shrimps on liver and horseflesh, and where my man washes his meat sieve the snails have collected in heaps and devour all that is washed off the sieves My experience has taught me that one yearling fish is worth a hundred or a thousand fry for stocking purposes, yet I do not deny that a great many fish can be saved in the fry stage by artificial feeding. I get fewer fish, perhaps (by feeding natural food), but I get monsters of 6, 7, 8 and 9in. in a year, and my yearlings fetch three times the price of some other pisciculturists. Public opinion also in England is in favor of yearling or two-year old

fish for stocking purposes, and the results are more satisfactory by far. We cannot get anything like enough yearlings or two-year olds to supply the demand, and most people over here have given up stocking with fry. There is of course a sale for fry in England, as proper rearing ponds have in many cases been made, but the general opinion is in favor of yearlings."

Mr. Andrews's letter shows the way to vast possibilities, not only in the line of rearing trout fry in ponds on natural food, but in supplying mature fish in wild waters with a generous addition to their larder by transplanting eggs, larvæ or imagos of various insects. It is a most fascinating subject, but the pages already written warn me that I must be brief. The alder-fly and grannom-fly, referred to by Mr. Andrews, belong to the dun tribe, the former being the alder, orl or light dun, and the latter the green-tail or shell-fly of the fly-fisherman. The duns belong to the family *Phryganidæ* and are called caddis-flies, and the larvæ are called caddis-worms, and are sometimes confused with the May-fly, which they should not be. The dun or caddis-flies are so common, that a description of any one of the score or more species is unnecessary. The larvæ or creeper cases are hollow cylinders, smooth inside, composed of straw, grass roots, small stones and shells, and closed at one end. They are excellent trout food; every trout fisherman is familiar with them, and they are easily collected for transplanting. D. Barfuth, of the University of Bonn (Report U. S. Fish Commission 1873 and '74 and 1874 and '75, p. 735), examined a number of the common trout of Europe (*fario*) and found these to contain the creeper cases of *Phryganidæ* as follows: In one, 136 cases; in another, 585; in another, 116; in another, 186, and in another, 115. Of six trout examined, the cases were found in all the stomachs, and also in the entrails; in one, the intestinal canal, as far as the anus, was completely stuffed with the cases.

A book written by a lady for fly-fishermen, with the title, "Favorite Flies," soon to be issued from the press of Houghton, Mifflin & Co., Boston, will contain six plates of natural insects, including the different stages, of the May, caddis, stone and other flies.

Last year I experimented with the May-fly, *Ephemera*, to discover if it could be transplanted to waters where it was unknown, and found that it would bear safely a journey of twenty-four hours, at least. This fly is called the dog-fly, and one of the species—there are more than two dozen—is called shad-fly, and they are the "drakes" of the fly-fishermen, the "green drake" being the largest and best known Of the abundance of the May-fly it is said (Westwood's Introduction to the Classification of Insects), that in some pools of Europe it is customary to collect their dead bodies and use them for manure. The distinguished naturalist Reaumur gives this account (Introduction to Entomology: Kirby and Spruce): "The myriads of *Ephemeræ* which filled the air over the current of the river, and over the bank on which I stood, are neither to be expressed nor conceived. When the snow falls with the largest flakes, and with the least interval between them, the air is not so full of them as that which surrounded us with *Ephemeræ*. Scarcely had I remained in one place a few minutes when the step on which I stood was quite concealed with a layer of them from two to four inches in depth." This was near the River Marne, in France.

I know personally of but few places where the flight of May-fly is in clouds, but in one place in New York it closely approaches, if it did not equal, that related by Reaumur. In a flight of May-fly there will be discovered green, gray and purplish-black drakes. At first all are green, the female changing to gray and the male to purplish-black. Before my experiments with the May-fly on drakes, had extended beyond confining them to see how long they would live, the *Fishing Gazette*, London,

printed an article written by Major W. G. Turle, in which he described a completely successful experiment in transplanting and establishing the May-fly in waters where it was previously unknown. I gathered my flies in a bait bucket and a tin biscuit box, but Major Turle improved upon that by using band-boxes with lines of worsted from side to side for perches. The flies were caught by picking them from the bushes and placing them in the boxes, and the boxes were taken by railroad train to the waters which it was desired to stock, and there the flies were released on the bank. Major Turle was of the opinion that it required two years for the eggs to mature, but, as will be seen from Mr. Andrew's letter, it requires but a year. The illustration of the larvæ or creeper of the May-fly used in this paper was prepared for Mr. Frederic M. Halford's work, "Floating Flies and How to Dress Them," but was rejected for another process, and was very kindly loaned by Mr. R. B. Marston, editor of the *Fishing Gazette*, London, and a corresponding member of this society.

The illustration is 5in. long, and a particularly fine cut, but the natural creeper is less than 1in. in length. The larvæ as well as the fly can be transplanted, and besides furnishing food for the fish the diet may teach and encourage the trout to rise to a fly.

The Chairman invited remarks and discussion on the two papers now before the society:

Dr. James—The subject of "Food for Fishes" is much too important to be passed without discussion. I was very much interested in the paper, because it leads to the all-important subject of giving us good fish. If our fish are lean and have not a good flavor, we certainly lose all enjoyment for that kind of food; and the more we can improve the variety as well as the fatness or quality of the fish, the better it is in the market. Of

course the more valuable any of these fishes become to us as articles of commerce, the greater the desire of those who fish to obtain these better varieties.

It seems to me that this is a subject that ought to be taken into consideration not only by the different States and by those who are in the habit of making fish culture part of their business or their pleasure we may say, but that it ought to be in some way encouraged by the government. There are out in the Rocky Mountains, many of the streams off in the mountain districts that are not yet well known and uninhabited, that ought to be stocked with fish. In stocking these fish, this subject of preparing food for them, or the kind of food on which they can survive, ought to go hand in hand. There are thousands and thousands of persons who are dependent on the internal fish supply away off in the interior of our country, which supply can only be kept up by stocking the streams and lakes which have their sources in the Rocky Mountains and the other mountains north and south. And the government really should, it seems to me, take this whole matter into consideration, and while it is transplanting the eggs of different kinds of fish that will survive in those waters, they should make a general law which would not only stock them, but supply the proper kind of food. Out in those waters in the Rocky Mountains, where there is nothing else but rocks in some places, there must be some sort of material supplied such has been suggested by this paper. Those of you who have been there will have noticed the contrast between the rich, luxuriant growth we have here in the East, where there is a great amount of moisture, where there is a great supply of those kinds of flies, insects and other animals, which are not to be found out there. Some varieties of this food probably could not be transplanted, but certainly there are some which would grow there and flourish. But of course there is no use placing them there until the fish have been grown and transplanted.

MR. MATHER—This subject of food is the one important subject. It has been stated several times that in Europe there is somebody who has a system by which he breeds insect life and small crustaceans, and drives his little fry from one post or point to the other. I have investigated to some extent, and I never could find anybody that could show that it was a practical thing to be done. Of course wild trout feed largely upon insects, but I have never seen any way clear to breeding insects in quantities sufficient to feed any number of trout. If a man has a pond with only four or five thousand trout in, it is possible there may be insect life enough to support them. But I did try years ago—it must have been twenty years ago, I think—to breed mosquito larvæ for trout; it was very good food for the little fellows; the only trouble was to get enough of it. Taking rainwater barrels, and straining them and getting the larvæ out; and the little trout feed well on it. The trouble was to get it in quantities—to get pounds of it. Another trouble is that the mosquito larvæ does not come quite early enough for those that are in the earliest stages and begin to want food.

But the May-fly and its larvæ are excellent food for trout. I have seen them on the Hudson River when I have been hatching shad; at nights they would sometimes darken our lanterns, and wash up along the shore the dead bodies in such quantities so that you might smell them. Along the Hudson and Connecticut Rivers they are known as the Eel-fly. But how to propagate those things, to get enough so you could estimate it by pounds, I really don't see the way, but I should like to very much.

MR. GILBERT—It has been my experience in regard to freshwater shrimp, we always find them in every good trout stream—in Massachusetts especially. Trout must have a temperature of water not above sixty-five degrees at any time, but rather a temperature of not far from fifty degrees. They will germinate, thrive, breed

and increase in water of that temperature and none other. In my brook, you take up a watercress, or any kind of aquatic plant, and it is literally alive with freshwater shrimp. We do nothing to breed them or increase them. Trout are feeding on them all the time; I presume there are hundreds of thousands. In one place I have got 20,000 yearlings that are from four to seven inches long. There are more or less aquatic plants in the brook; take one of them up and it is actually alive with the freshwater shrimp. They must increase very fast, for these yearlings are constantly feeding on them.

Now in regard to the feed of young fry: We begin to feed along about the first of April, and at that time of year there is any amount of (heidic) spawn, in March and April, and that has been in my experience the best feed that I could get as food for the young fry. I can buy any quantity in Boston; I presume you can in New York. I have got it up to about the 20th of May. Up to that time we feed on (heidic) spawn exclusively. After that, by the time that is gone, they are an inch and a half long, some of them two inches in length, then we begin to feed them on liver, pulverized very fine.

THE PRESENT STATUS OF TROUT CULTURE.

By Wm. P. Seal.

Trout culture may truthfully be said to have been, since its inception, the great fishcultural school.

Whatever doubts may have existed in the past regarding the fundamental and underlying principles of fishculture, they no longer have a place in the minds of those who are cognizant of the present aspects and results of the development of the science. Fishculture is no longer on the defensive, but stands to-day showing economic results not achieved by any other branch of public work. Whatever attacks are yet made upon it are levelled at trout culture generally. It sometimes happens that other branches of fishculture are assailed because of the effects of local changes in catch and distribution of fish induced by changes in fishing methods, as with the shad; and because these are not understood by the general public who do not see beyond their local fishing interests.

It is one of the misfortunes of our political system that for partizan advantage we often find a great deal of fault with everything originating with our political opponents, and that we are not satisfied to applaud unless the beneficial results of a public policy can be properly credited to our own particular party. We often differ on important public questions for no better reason, and with our legislators this often stands for statesmanship. It is probable, however, that there is in general less of partizanship in the support of fishcultural measures, and more of a common bond of fellowship among those interested in fishprotection and fishculture, than may be found in almost any other field of contemporary human interest. This is as it should be, and the bond should be strengthened, and the unholy leaven of partizanship cast out as unworthy of a place in the minds of men working in a

common cause for the general good. Otherwise the enthusiasm of men is repressed, the halting and inefficient find their way into places for which they are unfitted, selfish motives prevail, progress is retarded, and the public mind becomes suspicious and uncertain. On this account the removal of men engaged in fishcultural work, for political reasons, should be unequivocally and unanimously condemned and rebuked by this society. It will only be by the vigorous, unselfish and consistent action of those engaged in the work, that the bulwarks of safety for all will finally be established.

It is unfortunately the case also that among fishculturists, as among men engaged in other pursuits, a true scientific spirit does not always prevail. They are too easily satisfied and sometimes get into ruts from which they are not willing to emerge. When a man starts out with a preconceived theory, and spends his life in seeking for arguments to sustain his position, instead of searching for the truth alone, he makes but little progress. Truth alone should be the goal, and whatever suggestion there might be from any source should be seized upon and examined with unprejudiced mind. "What is the truth in the matter?" might well be the scientific worker's creed. A little broadening of our views and the inculcation of an ardent scientific spirit might result in a much more rapid progress in fishcultural development, now that there is no longer uncertainty as to its economic value. The urgent insistance of fishculturists in favor of their particular methods, while decrying those of others without thorough experiment and observation, though it may show a confidence calculated to be assuring, is not so strong as an argument, as a more patient and painstaking investigation would be. Moreover, where conflict of opinion reaches such a pitch that each side denounces the work of the other as impracticable, or of doubtful utility, unless it is a very clear case, the public mind is apt to decide that

there is a strong possibility of correct judgment on both sides.

The wide divergence of opinion among trout culturists at the present time, as to the most effective methods of stocking, with the counter-argumeuts made, is not assuring to many well-wishers of this branch of fishculture. It seems to the writer that the time has not yet arrived when any phase of trout culture as yet developed in the United States, can be hailed as the ultimate limit of possibility, or that the experimental stage is passed.

It would be well, perhaps, before discussing the various aspects of trout culture, to recall the arguments in favor of and against this branch of fishculture as carried on at the public expense, inasmuch as the periodicals of the country devoted to the dissemination of whatever relates to fishculture are open to virulent attacks, by irresponsible cranks, upon those engaged in that pursuit, charging them with being robbers, engaged in looting the treasuries of the State and National Governments. It is the usual policy to allow such attacks to pass unnoticed, and, if there is doubt as to the value of trout culture, perhaps that is the wisest policy; but it has always seemed to the writer that the general public want, and have the right to know, the truth in the matter, and that if it can be shown by argument based on demonstrated experience, and not by unsupported allegations and invective, prompted by personal motives, that the work is of doubtful value, it should be abandoned for other branches of fishculture holding forth greater promisė of usefulness. It is certainly quite easy to bring very plausible arguments to bear adversely on this question when not considered broadly, or if one side of it only be touched, and it is the belief of the writer that inasmuch as it is generally conceded that to attain the best results in trout culture, vastly greater outputs, requiring greatly increased appropriations, are required, or, that more effective methods of stocking must be developed, it is

just as well that all attacks should be met by amicable and reasonable argument, as constant and persistent as the unsupported statements of its opponents. Once convince the people of its economic value of any phase of fishculture, and they will see to it that the legislators support it. Any dependence on partizan advantage, the support of a particular class of the population, or resort to "star chamber" methods in fishculture, will eventually result in disaster to the cause.

The most potent arguments against trout culture at the public expense, and especially as applied to the general government, are:

First, That a few localities only are benefitted by attracting anglers thereto, and that the work should be carried on by the sections benefitted.

Second, That the areas available for the purpose are rapidly diminishing by reason of the denudation of the land, thus destroying the great natural storage reservoirs and producing an alternation of droughts and floods, causing the destruction of the natural food supply, and raising the temperature of the water, and that nothing permanent can be accomplished and therefore the results are not, and cannot be, commensurate with the outlay.

These arguments, of course, have no weight with the angler; but public fishculture can be permanently established and maintained only upon economic considerations, and nothing is to be gained by evasion. It is therefore proper in the best interests of fishculture to refer to them, and to see if there is not a valid answer to them.

The advantages of healthful recreation to thousands of our best and greatest citizens might be advanced, but it is not sufficiently strong as an argument in the premises. There is, however, no doubt of the fact that a much greater interest and sympathy is awakened in the interest of fishculture generally through the more universally under-

stood methods of trout culture than by any other means. It has been in fact the nursery, the kindergarten, and college of fishculture. But for the persistence with which it was followed by a few enthusiasts, while many fell out by the way, fishculture to-day would be still looked upon as an impracticable dream.

To-day trout culture has become largely supplementary to much greater branches of fishculture, but as a training school in the handling of fish it is yet paving the way to still greater fishcultural triumphs. The knowledge that is being gained by experiments in hybridization, acclimatization (transfer and adaptation), the studies upon the variation and modifications of species under changed conditions, although not as systematic and well sustained as is desirable, are of great value as observations and training which will have an influence and bearing on other phases of fishculture as they may be developed in the future.

The economical handling of live fish, once so difficult, is rapidly being reduced to a science largely through the experiences of trout distribution, they being among the most difficult fish to transport. The keeping of trout in aquaria has been revolutionized by reason of experiment in this direction, the use of ice now not being considered necessary under a temperature of seventy-five degrees.

The treatment of diseases of fish and the destruction of fungus on them is making progress mainly through the handling of trout.

These, of course, may be considered as minor points only among the beneficial aspects of trout culture. The most important argument to be advanced is that it is believed by all who are familiar with the subject that from a financial standpoint the aggregate of trout used for food in the United States could pay many times the sums devoted to their propagation. There is no question but that for artificial propagation they would have long since been exterminated. As from the very nature of the methods

of catch and distribution of trout as food, they not forming commercial fisheries, there can be no collection of statistics bearing thereon; this is a favorite point of attack.

Whatever differences of opinion may exist regarding the economy or efficiency of the opposing methods employed in trout culture, the question remains as to whether the best possible results have been attained and whether there is no stimulus to further investigation and experiment.

The economic cultivation of trout is assuming such importance as to cause in the State of Massachusetts a lively agitation concerning the marketing of such as are reared by artificial means during the close season. One of the claims of the opponents of trout culture has been that it is impossible to cultivate trout for market economically. The value of this fact, therefore, should be appreciated as a great triumph of fishculture and should receive all encouragement. To be universally popular, fishculture must be based on economic or food considerations, and not on those of sport. Therefore it is to the interest of anglers to make such concessions in matters of this kind as to convince the general public that they are actuated by motives not wholly selfish. It is only by fair and politic treatment of such questions that the sympathies of the people will be aroused in the general interests of fishcultivation and protection, and through which the interest of the angler will be most effectually advanced. The opposite course will only keep alive the doubts and objections which prevent their advancement. It is only necessary to note the meagre appropriations of the State of New Hampshire, the efficiency of whose work is attracting universal attention among fishculturists, to show the lack of general appreciation. Neither fishculturists nor anglers can afford to take ground that will retard the business of rearing trout for market. And the people themselves will decide the question of quality.

The ancient Romans had their pampered eels, and may not we have our pampered trout if we like? Are not frozen fish better than no fish? As well need we distress ourselves that everyone cannot have fish right out of the sea! Certainly, also, if the cultivated trout is so easily distinguishable from the wild, as is generally alleged, there should be no difficulty of providing adequate safeguards against the violation of the laws protecting wild trout.

It should be remembered, at all events, that whatever will demonstrate the economic value of fishculture is the strongest possible argument, and the most potent influence, in its promotion.

One of the anomalies of the trout culture of to-day is the division of sentiment regarding the planting of yearlings and fry. It is claimed on the one hand that the planting of yearlings is much the more efficient method and instances are brought forward where repeated plantings of fry have failed to produce an effect on streams, whereas they have finally been successfully stocked with small plantings of yearlings.

The arguments in favor of planting yearlings are that being grown to a length of three to five inches they are better able to escape their enemies and to protect themselves against the Cottoids (millers'-thumbs and darters) infesting all rapid-running streams, where they harbor under the stones. There are also crayfish and large insect larvæ, such as the "helgramite" or "dobson" (larvæ of Corydalis Cornutus), which will destroy the fry as they take shelter under the stones.

Turn over the stones in a trout-brook, and small fish (*Cottoids*) will be seen to dart to shelter under other stones. These exist in great numbers in all such streams but escape observation except of the collector. They will destroy fry as soon as deposited. Not so the yearlings which are able to turn the tables on them and to devour at least the smaller of them. Many experiences

in Europe and the United States are given in support of this belief.

There is another argument which has been advanced in the fact that in depositing yearlings they can be actually counted and there can be no ground for suspicion concerning the statistics of output.

On the other hand it is argued by some that the cost of rearing yearlings will not warrant it. It is also argued that when fish are brought to the yearling stage in captivity their natures will have become changed, the natural instinct of self-preservation will be lost, and thus they will become an easy prey to their enemies.

It is also said that if fry are properly planted—that is, in the head waters or feeders to trout-brooks (spring streams)—there is but a small percentage of loss among them.

While the writer is only presenting these opinions as a preliminary to the unfolding of the object he has in view in the preparation of this paper, he cannot refrain from saying that all his experience in the examination of small cold streams has shown them to be swarming with crayfish, cottoids and salamanders, clear to the fountain heads, the springs. That these are not noticeable to the casual observer and that their presence will not be known except by removing the stones. The "helgramite" is not always present, but the others are rarely, if ever, absent.

Now in the best interest of trout culture, is not this a question worthy of closer examination and more extended experiment? Is it well to consider the matter settled one way in one State and in a different way in another State? Ought not the question be the subject of continued experiment in the States interested in trout culture, without bias and with a desire to develop the truth only? Do not the best interests of trout culture require a sympathetic and progressive treatment of the subject?

If, however, on the other hand, trout culture is established on so firm a basis that those engaged in it may safely indulge in dissensions and that we may consider that the ultimate of possibilities has been developed, the writer has only to apologize to the trout culturists of the country for his temerity in approaching the subject.

This brings the writer to the point which he desires especially to present for consideration. At the last meeting of the American Fisheries Society, there occurred some desultory discussion concerning the cost of rearing yearling trout, during which reference was made to certain methods of producing natural food for the purpose, now used in Europe. It was developed that but scant consideration had been given to the methods in question and that but little was known about them. Those who are sufficiently interested in the subject will find much of value in three papers, herewith appended, from the Bulletin of the U. S. Fish Commission for 1887 (Vol. VII., pages 203 to 215), viz., "Self-Producing Food for Young Fish," by Frank H. Mason, Consul; "The Piscicultural Establishment at Gremaz (Ain), France," by C. Raveret-Wattel, and "Report on the Piscicultural Establishment at Piedra, Aragon, Spain," by F. Muntadas.

Perhaps the only fishculturist in this country who has given attention to the production of natural food for young trout, or at least who has recorded the same, is Mr. Charles G. Atkins of Maine, but his experiments appear to have been confined to the larvæ of flies (otherwise maggots), but in a somewhat improved manner. The following items bearing on this question of natural food are taken from the report of the U. S. F. C. of 1882, p. 1,011, viz.:

"Thus the *Deutsche Fischerei Zeitung*, 1880, p. 25, maintains that by feeding trout on worms their weight can be increased in one year from three-fourths of a pound to two and a half pounds;" and "As regards feed-

ing fish on snails, Dr. Molin says in his 'Rationellen Zucht der Suswasser Fische,' p. 13, that Commander Desme had a pond containing 150 hectolitres on his farm at Puy Girard, in which he fed young salmon and trout on pounded snails, and by this method of feeding he increased their weight on an average by one pound per fish."

That forms of life inhabiting the water and being equally or more prolific than the flies or worms would be far preferable, needs no demonstration.

However we may differ as to some features of the methods recounted in the papers in question, the fundamental principles are essentially the same and deserve careful consideration, as numberless adaptations of them may be evolved.

A paper by Mr. A. N. Cheney, entitled "Stocking Trout-Waters With the May-Fly," which appeared in *Shooting and Fishing* of March 31st, 1892, has still another and a very practical bearing on the subject in general.

The propagation of natural food has been followed for a number of years by the writer in the cultivation of ornamental fishes with complete success, the possibilities in the production of crustaceans being limited only by the space devoted to it. Further than that, if space was lacking for the purpose no difficulty was ever experienced in getting abundant supplies from nature. It is only a question of knowing how to go about it. Stagnant waters everywhere, and especially those destitute of fishes, abound with certain kinds of them, but principally with Daphnia and Cyclops. Watercress beds and masses of other aquatic plants are alive with other kinds of them, such as Asellus Vulgaris (Water-hog, water-asel) and Gammarus pulex (freshwater shrimp). Masses of dead leaves in the waters of springs or spring streams harbor them in great numbers. But the conditions in nature that promote their development are not nearly so

favorable as they can be made by combining the natural and artificial. There is no necessity for the introduction of any foreign material to stimulate a production of the crustaceans, as the natural conditions afford all the requirements for sustenance, but infusions of dung or vegetable matter will attract ephemera and other flies to deposit their eggs. Nor is there any necessity for driving fish from one pond to another, as the food can easily be caught and transferred to the fish basins.

Let any trout culturist make a small cheese-cloth net, and using it among water cresses or other aquatic plants in shallow water, note the immense numbers of larvæ and crustaceans that may be taken.

Or, make the experiment of spreading the water flowing from a spring so as to make it shallow. Plant it thickly with water cress and nature will speedily stock it with animal life. Again, take a small pond or trench without fish and put into it a few Daphnia and Cyclops, and note the result.

The experiences of the writer confirm those of the European fishculturists who have applied these methods to trout culture, and he has no hesitation in recommending them to American trout culturists as worthy of general development. They are applicable as well to the rearing of any kind of fish, carnivorous or vegetarian (so called).

The writer took the ground at the last meeting of the society that the time would come when greater areas would be devoted to the rearing of natural food for young fish than to the holding of the fish themselves, and that enough food to rear a yearling trout can be produced within the limits of a cubic foot of water.

The advantages of an artificial system over purely natural conditions in the production of these creatures is the same as in the propagation of fish. Where exposed to the ravages of the fish themselves the multiplication will be slow, if not wholly arrested, because the breeders

will be destroyed as well. In separate basins, however, there is no restriction on the production and the fecundity is so great the accumulation is enormous. Thus while one basin is being depopulated others can be repopulated.

For young fry the smaller crustaceans (Daphnia and Cyclops) are required. When probably one and a half or two inches long they will be able to take the larger ones. Young trout in aquaria will always take these in preference to dead food, as it is natural they should.

This work may be carried even further by making wood or cement lined trenches, covered with sashlike hot beds, through which the waters of springs may flow, for both the fish and food; the inlets and outlets to be protected by wire gauze. Such methods involve more expense in the beginning but might prove less expensive in the end.

It must be confessed that the writer's only practical experience in this direction (except in the handling of trout in aquaria) has been with ornamental fish, the gold fish in particular. With these he can say from actual experience that as many can be reared in a cemented basin covering 200 square feet and costing not over fifteen dollars (necessarily), than is usually produced in a natural pond of half an acre, and further, that the same results can be produced season after season without variation, which is not the case in nature.

And the reason is that in the pond the earlier hatchings will eat the later ones, while in the artificial basins they can be apportioned according to size. The old ones will eat the young. The young ones become the prey to innumerable forms of pond life from the voracious hydra to the multitude of water insects and larvæ, crayfish, frogs, snakes, herrons, kingfishers, etc. These elements of destruction, everywhere present in nature, can be wholly eliminated by the adoption of a proper system, while at the same time all the advantages of natural conditions may be afforded.

In the cultivation of gold fish it is possible to retard the growth by the feeding. This would not be desirable in general fishculture and is only referred to as an evidence of the advantages to be gained by an established system over absolutely natural methods.

Whatever reception awaits it, the presentation of this paper can at all events do no harm. It simply reflects the opinions of the writer looking at the question from a standpoint somewhat apart from that of the trout culturist or the angler, but possibly, however, with a more ardent belief in a progressive future for trout culture than is evidenced by either. A full discussion of such questions is certainly calculated to advance the development of the latent possibilities of fishculture. This belief, at least, is the writer's justification for trenching upon a field where he is not a practical worker, but an interested observer only.

(Bulletin of the U. S. Fish Commission, 1887, p. 207.)

THE PISCICULTURAL ESTABLISHMENT AT GREMAZ (AIN), FRANCE.

By C. Raveret-Wattell.

About four years ago I had the honor to call the attention of the National Acclimatization Society to a pisciculturaI establishment which had been founded in the Department of Ain, at Gremaz, in the township of Thoiry, for raising trout as an industry. I pointed out the special interest which, in my opinion, this establishment seemed to possess, as its founders, Messrs. Lugrin and du Roveray, have succeeded in solving a problem of considerable importance from an industrial point of view, viz., to furnish the young fish with food solely composed of living prey proportioned to its size.

It was exceedingly important to find some natural food

for the young fish, and since Messrs. Lugrin and du Roveray have demonstrated the great usefulness of the Daphnia in this respect, several pisciculturists have looked for some practical means of providing a sufficient quantity of these small crustaceans. Attempts to multiply them rapidly in ditches filled with slightly muddy water succeeded; but this method presents serious inconveniences. According to Mr. Chabot-Karlen, the Daphnia gathered in these ditches are extremely tender; the least agitation kills vast quantities; the greatest precautions are therefore required to gather them; and, moreover, these small crustaceans impregnated with muddy water must be carefully washed in clear water, in order not to become actual poision for the young fish.

The method employed in the Gremaz establishment is by far preferable. As I have stated in my previous report ("Bulletin de la Societe d'Acclimatation," November, 1882), the Daphnia are raised in the very basins which are destined for the fish. When a basin has been sufficiently prepared for the development of these small crustaceans, they are allowed about a month's time to increase; then the fish are put in the basin, where they at once find abundant and substantial food. Whilst this stock of food is being consumed, other provision is made. A neighboring basin is prepared like the first; *i.e.*, it is abundantly stocked with Daphnia. After another month has passed, the fish—which by that time have consumed nearly all the food in the first basin—are put in the second, where they again find ample food. A month later they are again put in the first basin, which meanwhile has again become stocked with Daphnia, and so on. This method is extremely simple and convenient. Messrs. Lugrin and du Roveray, however, do not confine their efforts to raising Daphnia, but they likewise use larvæ of insects, and especially small freshwater shrimps, which, as we shall see, form an exceedingly abundant article of food, particularly in winter.

When, in the year 1882, I visited the Gremaz establishment for the first time, I was positively astounded at the quantity of Daphnia in the basin, forming dense clouds in the water. But that was the beginning of October, after a long period of fine and warm weather, during which these small crustaceans had had a chance to multiply at an enormous rate. I was, therefore, curious to return to the establishment to see how matters stood during the bad season. From this point of view no better moment could have been selected for my visit. Without being exceptionally severe, the winter in this region has been somewhat prolonged. Shortly before my arrival the thermometer had fallen to 13 degrees below zero. On the day of my visit it was still 3 degrees below zero, and the basins, which had a feeble current of water, were covered with ice. The ice had been broken in several places, and we could, consequently, examine the water underneath. I must say that the Daphnia appeared to me to be just as numerous as during the fine season, which, however, is easily explained in water as cold as that in these basins; but when we dipped out some of the water from the bottom of the basins, with a sort of canvas purse net, we brought up incredible quantities of larvæ of the Chironoma and still more larvæ of the Ephemera. The whole bottom of the basins seemed to be one mass of animal life. At every haul we got a big dish full of these larvæ which are an exceedingly valuable article of food for the young fish. The water which is artificially prepared for the Daphnia is, therefore, likewise well suited for the developement of other small aquatic animals which can be utilized as food for young fish.

But Messrs. Lugrin and du Roveray are not contented with this source of food. Alongside of the basin there are small rivulets artificially made for raising small fresh-water shrimps (Gammarus pulex) which, by a method similar to the one employed for the Daphnia, are caused

to multiply in enormous numbers. In these rivulets, filled with water cresses and other aquatic plants, the little shrimps, which form so important a part of the food of the trout, are raised. Every day the daily rations allowed to the fish is gathered with nets in a few minutes; and it is a curious spectacle to see this food given to the fish. The young trout come from all directions in dense masses. They vigorously attack the little shrimps and do not allow a single one to get to the bottom of the water. No matter how large the quantity of shrimps it vanishes in a few moments.

The young fish of Messrs. Lugrin and du Roveray thrive admirably on this diet. Three basins, each having a surface of about 120 meters, contained about 70,000 fish of this year's raising, grouped according to size, and all in excellent condition. From their well developed stomach and their finely rounded forms, it will be seen that these fish have not only never suffered hunger, but that they have always had abundant food of excellent quality. This kind of food, composed exclusively of insects and small crustaceans, is exceedingly suitable for these young fish on account of the large quantity of phosphate of lime which it contains; (1) and this circumstance explains the rapid growth, and the exceptionally fine and vigorous condition of the young trout raised at Gremaz.

It may be well to add that the profitable use made of the small shrimp streams will soon give way to a still simpler method of utilizing these small crustaceans, by proceeding in exactly the same manner with Daphnia, *i.e.*, the fish will be successively, or rather alternately, passed from one basin to the other, to consume a stock

(1.) It is well known that the substance which forms the skeleton of insects and crustaceans is, with many species, largely composed of calcareous matter, and is exceedingly rich in phosphate of lime. It is probable that to this circumstance must be attributed the result of Stoddard's experiments: "Three lots of young trout were placed under absolutely identical conditions; one lot was fed on fish, the second on Annelida and mollusks, and the third exclusively on insects. All the fish of the last-mentioned lot developed much quicker than those of the others." In England insects are also considered excellent food for young trout.

of food previously prepared for them. By experiments Mr. Lugrin has ascertained that a basin 35 meters (114.8 feet) long, and 3 meters (9.84 feet) broad, with an average depth of water of 40 centimeters (1.3 feet); (2) may contain 20,000 young fish from eight to twelve months old, or 3,000 two-year old trout, having an average weight of 250 grams ($\frac{1}{4}$ or a little more than $\frac{1}{2}$ pound). These 20,000 young fish or 3,000 trout, consume about 10 kilograms (about 22 pounds) of small shrimps per day; (3) or 300 kilograms (about 660 pounds) per month. It has been proved by experiment that a basin having the above-mentioned dimensions can produce 300 to 350 kilograms (660 to 770 pounds) of shrimps, without at all interfering with the Daphnia, Nais, Limnea, insect larvæ etc., which simultaneously develop in the same basin. Under these conditions food will never be lacking. It is sufficient to have two basins for each lot of fish, so as to transfer then each month from one basin to the other.

The system employed at Gremaz is, therefore, exceedingly profitable from an industrial point of view. But it is specially destined to render excellent service in stocking rivers with fish. Doing away with all the difficulty as regards food, it makes it possible and even economical to keep young fish, intended for stocking rivers, for a certain time in the basin free from all danger. Those young fish, which, owing to the lack of suitable and sufficiently cheap food, had to be set out in the rivers at a very early age, before they had had time to gain strength, may now be safely left in the basins till they have grown stronger. When several months old the young fish is already vigorous; it knows how to flee from danger; it is, therefore, better able than younger fish to escape numerous accidents and causes of destruction. Rivers, there-

(2.) These are the dimensions adopted for the new basins of the Gremaz establishment, the projected enlargement of which contemplates the creation of 136 such basins.

(3.) Ten kilograms (22 pounds), dry measure, of small shrimps represents about 7 litres (about $1\frac{3}{4}$ pints of liquid measure.

fore, may be stocked with much greater prospect of success; and it may safely be asserted that 3,000 or 4,000 young fish, ten to twelve months old, are infinitely more valuable for stocking a river than 10,000 or 15,000 very young fish, which, not being strong enough to bear the change from the basin to the river, often perish in large numbers when placed in the river, where they become an easy prey to older fish living in the same waters.

This opinion is at this day shared by the vast majority of pisciculturists in Great Britian. Nearly everywhere in England and Scotland it is considered that the best young trout for stocking rivers are those which are about a year old, and which for this reason are called "yearlings" (4).

These young fish are strong enough to seek their food and consequently to avoid the principal cause of mortality in young fish, viz., inanition; they can easily be transported and will bear a change of water without difficulty. These young fish cost, it is true, considerably more than others, but as the final expense is much less, and the result is more prompt and certain, there is an absolute advantage in using them for stocking rivers.

There is only one point in the system which leaves something to be desired. If one operates on that large scale which is required for stocking an entire river, it envolves considerable labor to insure the feeding of the young fish with artificial food. As the animal is, so to speak, made during its early age, and as during this period its assimilating organs acquire their strength and their power of absorption, a young fish which is insufficiently fed not only grows very slowly, but will never become a fine fish. It has been ascertained long since that if, of young fish of one and the same hatching, one

(4.) This term is really applied to fish which are in many cases from ten to fourteen months old. Practically speaking, the age of a fish is counted from the date when it begins to eat, and not from the date when it was born. Thus, a trout of 1887 is a fish which commenced eating in February or March, 1887, although it may possibly have been born about the end of the year 1886, and not in the beginning of 1887.

portion is immediately placed in the river, whilst the other portion is kept in basins and fed with extreme care, the first will, after a short while, be twice as large as the second, because they have food which is better adapted to their needs; only, the loses among those which have been kept in basins will not be as large (unless the circumstances are particularly unfavorable), whilst the ranks of those which have been placed in the river have often been thinned to such an extent as to leave hardly any. They have fallen a prey to water rats, perch, pike, and even older trout.

Thanks to the system of raising employed by Messrs. Lugrin and du Roveray. all these inconveniences disappear; kept in basins, protected against all danger, the young fish, abundantly fed on live food, develop as well if not better than under natural conditions without involving any serious expense for their food; and when the suitable moment has arrived, they can easily be transferred to the waters for which they are intended, without running the risk of losing many.

It is therefore greatly to be desired that the Administration should abandon the use of very young fish for stocking rivers (as they are nearly all doomed soon after they have been placed in the river), and give the preference to fish ten or twelve months old, which, as is stated above, have yielded the most satisfactory results in England and Scotland.

Messrs. Lugrin and du Roveray, convinced of the advantages of their system, propose, at their own expense, to stock a water course which, being subjected to special supervision, will enable them to make an absolutely convincing experiment.

(Bulletin of the U. S. Fish Commission, 1887, p. 211.)

REPORT ON THE PISCICULTURAL ESTABLISHMENT OF PIEDRA, ARAGON, SPAIN.

By F. Muntadas.

All persons who devote themselves to practical pisciculture will remember the change of opinion which took place some years ago, owing to the weakness of many persons whose experiments proved failures. Our Acclimatization Society, however, has never allowed itself to be influenced by the "piscicultural malaria;" it has always stood firm and preserved its faith in the future; it well understood that the discovery of two fishermen of the Vosges Mountains could not become merely a subject of curiosity or pleasure. It is true that a large number of amateurs have taken a wrong road, but many others have followed the right road, and have made marked progress in the successful method of raising salmon.

From the moment that the question of raising large quantities of young fry and young trout was agitated, it became necessary to pay attention to many different circumstances, and not to forget the cost of raising fish; for the problem is to derive some profit from the new industry, and, according to Mr. Larbaletrier's expression, "to make money by pisciculture, and not pisciculture by money."

All the methods of artificial feeding are expensive, and, what is worse, do not entirely answer the purpose; it therefore became necessary to find and use natural elements. In short, it became necessary to give the young trout what it needed.

I had read in the "Treatise on Pisciculture," by our late co-laborer, Mr. Carbonnier, that in places where the freshwater shrimp (Gammarus pulex) is produced, the

raising of salmonoids was easy. I ransacked my waters for these precious crustaceans, and, having found them in considerable quantities in the sources and along the course of the Devil Rock Brook (Pena del Diablo), I went to work and had my first rearing-basin constructed. It was a complete success, and I had the honor to report it to the Acclimatization Society, which rewarded me by one of its medals. My young fish swallowed the little shrimps with the greatest delight, and seemed to care very little for the coagulated blood which was given to them in accordance with the instructions of the majority of treatises on pisciculture.

Ever since my first season I have used nothing but small shrimps for feeding my young trout, which grew amazingly fast. This method was followed during the first eight months. Later they found in the large basins (besides myriads of small shrimps) tadpoles, gudgeons, and craw-fish, of which they are very fond, especially during the shedding period of these crustaceans. In a special compartment I tried chopped meat (mutton, rabbit, etc.), but when I found that the carnivorous trout did not develop any quicker than the ichthyophagous ones, I fed them all on fish and crustaceans.

The enemies of the young fish (water snakes, water ousels, water rats, etc.,) committed great ravages in my open-air basins; and with a view to prevent these ravages, I had a basin constructed of cut stones 10 meters (32.8 feet) long, 1 meter (3.28 feet) broad, and 50 centimeters (1.64 feet) deep. The whole was covered by a small house with windows protected by gratings and a very close network of wire both down and up the stream.

The experiment had a two-fold interest, viz.: On the one hand to keep away the enemies of the young fish, and on the other to prove the success of my method of feeding the young fish after the umbilical sac had been absorbed. This twofold object was attained, and I am able to state

that not only was the loss smaller, but the young fish kept in this basin developed more rapidly than the others. When, in September, I transferred the young trout to more extensive waters, those which had come from the stone basin gained on the others in every respect.

In places where there is clear and cool water containing some lime, and where the freshwater shrimp reproduces naturally, I have discovered the best method of raising salmonoids. It therefore gave me great pleasure to read that at the Gremaz establishment Messrs. Lugrin and du Roveray had succeeded in solving the problem of raising young fish by the same means which I had employed here, and which I had described in the report which I had the honor to submit to the Acclimatization Society in July, 1872.

The closer we follow nature, the more certain we are of success. It may give an artificial pleasure to see a few young fish in a hatching-basin and to watch the absorption of the umbilical bag; some of them may even be kept for some time on more or less expensive artificial food; but when it comes to pisciculture on a large scale, when the object in view is to stock large sheets of water, these means are insufficient.

I well remember a long conversation I had with Carbonnier. He told me in a firm and convincing manner that, as I had on my property at Piedra a watercourse, which was always cool and limpid, and which had a considerable fall, I should abandon the Coste and all similar apparatus, and use the Jacobi box, placing it to half its height in the water (natural method), and, as I had large quantities of small shrimps, to give my fish small shrimps (natural food), and not think of any other food. I followed his advice, and my season of 1871-'72 was so remarkable that the Acclimatization Society rewarded me with the large gold medal at the public session of April, 1873.

From 1872 to 1874 I lived in France—two years lost to my pisciculture. On my return I had to begin over again; but as I felt sure of my method, I again set to work, and my establishment soon reached the high state of perfection which it had occupied prior to my visit to France.

The stone basin (mentioned already in my report for July, 1872) proved a great success. It produces on an average of 1,200 trout every year, and the open-air basins contain young fish by the thousand, more or less, according to the zeal and the efforts of the various fishermen in whose charge they are. The food is always the same during the first two months, small shrimps assorted, furnished two or three times a day; later, small shrimps such as are gathered with small purse-net attached to the end of a stick, at the sources of brooks, and in the large basins; for these crustaceans multiply wherever the water of the Devil Rock Brook is found.

Although trout placed in rivers consume an enormous quantity of these small shrimps, a great many remain attached to cresses and other aquatic plants. The positively prodigious quantity of small shrimps in the lake, the sources of the brook, and the large basins has so far not allowed me to think of raising these crustaceans in the rivers, and saves the trouble of transferring the trout alternately from an exhausted river to one still containing many of these small shrimps.

Our young fish remain in one place from March to September, and they are fed two or three times a day, as their needs seem to require it; and it is a curious spectacle to see them in dense masses pursuing their living prey. The quantity of small shrimps given to the fish two or three times daily weighs 5 kilograms (about 11 pounds). Having carefully counted the number of shrimps contained in 5 grams (about $\frac{1}{6}$ ounce), and found this number to be 672, the total quantity of shrimps fed to the fish in a single day is not less than 672,000, or 4,704,000 per week.

The importance of the fact that this food is furnished free of cost will easily be understood; and the circumstance that it is quickly distributed all over the basin renders it certain that all the young fish will get their share of food. One-third of the food is served to the trout in the stone basin, where the trout of the season of 1886 may now be seen. Such is the result of confining the fish for sixteen months.

No sun, no vegetation, no hiding places, no quiet retreats along the banks; and in spite of these conditions, which a theorist would consider disadvantageous, these trout measure 18 to 22 centimeters ($7\frac{1}{8}$ to $8\frac{5}{8}$ inches) in length. And to what is this owing? Simply to the abundance of food and the impossibility of finding hiding places. The crustaceans are devoured as soon as they are put in the basin, as there is no place where they could hide. It would be hard to find yearling wild trout as strong and fat as those which have been confined in the basins ever since the umbilical bag has been consumed.

Since the month of October last, the piscicultural establishment at Piedra has been rented by the Government. At this time there may be seen at the raising-basin thousands of this year's trout which have already reached an average length of 7 centimeters ($2\frac{3}{4}$ inches). These basins swarm with crustaceans, and nevertheless the three daily rations are never omitted. If one asks the fishermen as to the harvest of small shrimps, they invariably answer: "The more we take, the more there seems to be."

If the Government will construct inclosed basins on the existing model, it might try to acclimatize exotic species without fear of hybridization, which is an important point.

Mr. Raveret-Wattel points out the way to re-stock the rivers not only with young fish, but also with trout eight, ten and fourteen months old, as is done in Scotland with

those called yearlings. I entirely agree with Mr. Raveret-Wattel and the Scotch pisciculturists. If there is war, soldiers should be sent out, not babies; it is not the number which assures success, but the age and valor of the soldiers. Leaving this figure, which, however, shows the reason for employing yearlings, I venture to assert that if this system gains ground, the old system of stocking rivers should also be abandoned at Piedra, and the new system introduced. There will be no lack of food for the yearlings, for in digging out new ponds fed by the Devil Rock Brook it will be found that after two months they will be filled with cresses and other aquatic plants; and underneath these plants large numbers of small shrimps will be found, as has been the case in all ponds which have been dug, where many millions of these small crustaceans are caught every year.

In some places where the water freezes, the reproduction of the crustaceans is possibly suspended for some time. I cannot state this with absolute certainty, for I have not had occasion to make the necessary observations; but it seems to me that ice would not favor reproduction. In the lake and in the Devil Rock Brook the temperature, even during the severest winter weather, never falls below fifty degrees. This is really a spring temperature and I have with my own eyes seen small shrimps reproducing in winter as well as during the other seasons of the year. I doubt whether there is any other place as highly favored by nature for raising salmonoids, and also cyprinoids (tench, barbel) and crawfish.

Where the small shrimp is not found and the water contains particles of lime, attempts should be made to introduce it and favor its reproduction.

(Bulletin of the U. S. Fish Commission, 1887, p. 203.)

SELF-REPRODUCING FOOD FOR YOUNG FISH.

By Frank H. Mason, Consul.

Every person who has been interested in the artificial propagation of fish, and particularly trout and the several other species belonging to the genus Salmo, knows what care and labor are necessary to carry the young fry through the period immediately following the absorption of the umbilical sac, and to bring them to such a stage of maturity that they can be safely turned loose in open ponds or streams to shift for themselves. The mere hatching of the eggs involves no difficulty, and, under fair conditions, is ordinarily so successful as to make the propagation of fish in almost any quantity an apparently easy matter. But with the commencement of artificial nutrition the serious part of the task begins, and it is usually a small percentage of the swarms which are hatched that reach the maturity of yearlings, at which period the dangers of infancy are past. During the intervening months it has been customary to feed the young alewives on curdled milk, coagulated blood, finely-hashed meat and liver, grated yolk of eggs, macerated brains of animals, etc., the preparation of which, and the frequent feeding of the dainty little creatures, involves constant and more or less costly labor. Moreover, none of these forms of nutriment have been found entirely satisfactory, for the reason that they are all distinctly artificial and different from the living, organic food which nature provides for those species of fish during their tender, infantile period. The difficulty of providing proper nutriment results often in turning out the young fry into open water too early, when the temperature of the stream or pond is so much below that

of the tanks in which they have been hatched that they perish by thousands from chill and inanition, without making an effort to find natural food in their new element. Accordingly the problem has been to devise a natural, self-reproducing food, so easy and certain in preparation that it may be cheaply and abundantly provided, and thus facilitate the maintenance of the alewives during the first ten or twelve months of their existence, by the end of which time they should be so strong and active that a large majority may be relied upon to survive the struggle for life in larger waters.

The result seems to have been fully attained by a discovery made several years ago by Mr. F. Lugrin of Geneva, and practiced since 1884 in the piscicultural establishment at Gremaz, in the Department of Ain, in eastern France. As this process has been examined and approved by eminent experts, sent especially for this purpose by piscicultural societies of England and other countries, it is thought that some account of it may be of interest to the large and rapidly growing class of fishculturists in the United States.

Mr. Lugrin was for many years a practical fisherman on Lake Geneva. He noted the steady diminution of the more important species of fish in the lake, and sought to ascertain the cause He gradually reached the conclusion that the germ of the trouble lay in the growing scarcity of minute crustacea and larvæ which are the natural food of the trout and other fish, especially during their first months of nutrition.

After elaborate experiments, he hit upon a system by which Daphnia, Cyclops, freshwater shrimps (Gammarus pulex), etc., could be bred in countless myriads at merely nominal cost. The hatching and rearing of a generation of these minute creatures is the work of from twelve to fifteen days, and as the process may be repeated—or rather repeats itself—again and again in the same water, the problem would seem to be solved.

Whoever has watched from a place of concealment the trout feeding in an American stream has admired the adroitness with which they work down stream, raising with their noses the up-stream end of flat stones until the current, catching underneath, aids the clever little forager to turn over the stone and expose the minute larvæ and crustacea on which he so voraciously feeds. It is the purpose of the process now under consideration to raise by artificial means these same species of organisms, and in such quantities that the young fry may not only be abundantly fed in tanks or small inclosed ponds, but ample supplies provided for enriching larger streams and ponds where, for some reason, the natural supply may be insufficient.

The apparatus is simple, and visitors properly introduced have no difficulty in seeing the entire establishment at Gremaz, which occupies a gently sloping piece of ground, about six acres in extent and watered by three springs, which yield collectively about 500 gallons of water per minute. The tanks are rectangular excavations, about 120 feet long by 12 in width, with a depth of 5 feet. The ground being of a gravelly character it was neccessary to line the walls and bottom of some of the tanks with cement in order to retain the water, but in close clayey earth this would be needless, and the natural dirt bottom, if not to muddy, would be preferable to cement. The tanks have the same general level and are divided by sliding gates of wire gauze sufficiently fine to prevent the passage of the fry. Thus far all is simple and obvious. The process of Mr. Lugrin, which has been patented in several countries, consists in spreading upon the bottom of these tanks a material inpregnated with the elements necessary to produce spontaneously a limitless number of Daphnia, Cyclops, Limnea, as well as fresh-water shrimps, and the larvæ of various Ephemera which form the natural aliment of trout, and other Salmonidæ at all stages of their growth. Once constructed

and impregnated with this producing material—which is of trifling cost—these tanks go on with their work automatically and indefinitely. The water from two to three feet in depth, being left undisturbed two or three weeks, is found peopled with swarming myriads of minute organisms of the species above named. Twenty thousand trout a year old, or three thousand two years old—which last should average about one-half pound in weight—are considered sufficient for a pasture of that size, and the avidity with which they rush to occupy and ravage their new feeding-ground is a delight to the pisciculturist. If the propagation has been ordinarily abundant these 20,000 young fry or 3,000 yearlings will subsist royally in a tank of the size indicated for an entire month. They will eat on an average 20 to 25 pounds of food per day, or 600 to 800 pounds per month. Careful experiment has demonstrated that each tank at Gremaz will produce 650 to 900 pounds of Crevettes (fresh-water shrimps), to say nothing of the myriads of Daphnia, Cyclops, and other species produced in the same water at the same time. When, at the close of the month, the tank has become depleted, the gate is opened and the fish driven like a flock of sheep to new and similar pasture. The first tank, being closed and left in quiet, immediately begins the process of reproduction, and at the end of two or three weeks is swarming again with the varied minute organic life which far surpasses in value, as food for fish, anything that has been yet devised by man. Thus the simple, inexpensive process goes on from year to year, the fish always healthy and vigorous and larger at two years old than those artificially fed are at the age of three years. Yearlings bred in this way are strong and capable of making their way in any open stream or pond supplied with food and suitable for their existence. One thousand of such yearlings have been found more effective in stocking a depleted trout stream than fifty thousand young fry turned in, as has been so often done

heretofore, in order to get rid of them at the tender age when artificial feeding first becomes not only a necessary but difficult and troublesome. For these tender nurslings all open water, particularly when inhabited by older trout or other voracious species, are beset with a thousand dangers which the vigorous yearling is able to escape.

It is evident from all this that the system practiced at Gremaz is equally applicable to the industrial raising of trout and other fish for market. and to the restocking of streams and ponds for purposes of sport. In the first case it is only necessary to provide a series of tanks or small ponds from one to another of which the fish can be changed monthly, as herein before described, until they reach a marketable size; and it is to be remarked that trout raised by this method have the natural firmness and flavor of wild fish, and not the flabby degenerate character of those which have been fed on liver, offal, and other unnatural, degrading food. Once prepared, a tank or pond is permanently productive. However voracious the young fish may be, they leave the bottom of the water still peopled with myriads of parent organisms which reproduce so rapidly that, before the end of a month, the placid water becomes clouded with swarming millions of their progeny. The fecal matter dropped by the fish during their month of occupancy is sufficient to maintain the fertility of the bottom, and thus the system, once established, becomes automatic and self-sustaining.

A single attendant can have the care of a large establishment, his only duty being to drive the fish periodically from one feeding ground to another and close the gate behind them, as a farmer changes his flocks from one pasture to another.

It remains to be explained that while the Daphnia, Nais, Cyclops, and other extremely delicate species can be profusely grown only in still water, the fresh-water shrimp (Gammarus pulex) grows abundantly in living streams. At Gremaz rivulets are provided which

flow from the springs into the tanks and carry away the overflow. These rivulets, the bottoms of which have been impregnated by the Lugrin system, are filled with cresses and other water plants and produce the minute shrimps in such abundance that they are gathered daily in panfuls by a few sweeps of a gauze scoop-net and fed to the fish in the swarming tanks. This part of the process is easily applicable to natural streams where a sufficiency of food does not already exist.

As to the applicability of this system to American pisciculture, there is apparently no room for doubt or question. The same natural conditions which exist at Gremaz can be found in nearly, if not quite, every State in the Union. The same food which is produced there may be used in growing nearly every species of fish which is artificially reared in the United States. American brook trout, the rainbow trout and California salmon thrive admirably in the tanks at Gremaz.

To conclude with the verdict of Prof. Francis Day, who, in October last, came specially from England to investigate and report upon the system which has been so successfully established there:

"When I remark that a tank 35 meters (10 feet) long by 3 (10 inches) broad, and 40 centimeters (1 foot 4 inches) deep, and capable of containing 20,000 young trout can be fully stocked with food in fifteen days, so as to be able to sustain the residents for one month without any additional supply, I cannot help thinking that Mr. Lugrin has solved a difficult problem, and that his mode of cultivating the natural food of fishes will prove a great and lasting benefit to fishculturists."

MARSEILLES, February 25, 1888.

The following discussion then ensued:

MR. MAY—I want to call attention to the fact that this paper that was published by the United States Fish Commission, is largely theory. The man who says that from one cubic foot of water he can raise enough of the daphnia and crustaceans to feed a thousand trout, I should like very much to see him do it. As for sweeping a light net over watercress and getting enough to feed, it may do very well for the man who raises a thousand or two, as most fishculturists in Europe do; but if I should ask for ten pounds a day! Angle worms are no doubt good food, but how am I going to get them? If I want twenty pounds of little crustaceans, the little water flea, (the daphnia) and others, where will I get them? Or to collect twenty pounds of snails a day! it would cost more than anything I know of. The food question, as I have said before, is a vital one in fishculture. Most places can get cheaper food than we get, right near New York City, where there is a population that eats most everything eatable. In a paper which I will read by-and-by, I show that we have tried beef liver, which is very expensive here; we cannot get the hazlets of sheep, as they are called, because there is a large poor population here that buy them up. But I would like to see some practical man come forward and say that he has raised ten thousand trout and found enough of this natural food by sweeping a mosquito net over some watercress or something of that kind, and get ten or fifteen pounds of it during the day. I am an unbeliever in it, as you will probably see by this time.

MR. FAIRBANKS of Illinois—I did not come here with any idea of saying anything on this subject, but these papers have interested me very much indeed, and have been right in the line of what I am doing.

The remarks of Mr. Mather I regard rather as a challenge. I have at Lake Geneva, Wis., some trout ponds which I commenced there about fifteen years ago. I

began in the usual way of making ponds, and raised a good many trout by feeding curds, etc., as is usual. I am fortunately located on the side of a hill, which is all springs : dig anywhere almost, and you find a large spring; and I conceived the idea of making some natural ponds, and I have now some twenty-five ponds, varying in size from one hundred to three hundred feet in length and fifty to seventy-five feet in width. Some of them are smaller; some round, a hundred feet in diameter, perhaps. Scoop up an earth bank at the lower side, and let the spring come up and fill it. Some of them the weeds grow up in them naturally. Others, I take the weeds out of the little stream or outlet—I don't know the name of the weed, it is not the watercress that the freshwater shrimp inhabit; there is a little, low, close freshwater weed that fills the pond full almost, I take it out of places where it is already growing and put it in other ponds. That weed is alive with the freshwater shrimp, in its natural condition. I took out quantities of it and put it in these ponds, and they have filled up with it. I do not touch them or clean them out, but let it grow. I raise all my fry without a particle of food, until they are yearlings. I put in a pond 50,000 good healthy fry. I never touch them, never feed them, never look at them until they are yearlings. Some of them grow to six inches. This is a pronounced success, and a practical one; one which I am doing year after year.

Mr. Hoxie—I would like to ask what proportion of those little fry grow up to yearlings. If you put in 50,000 fry, how many yearlings do you get?

Mr. Fairbanks—I do not know that I can arrive at that. It is pretty hard work to count fish of that size. But all that I want. I should say fifty per cent. of them, as a guess; fully as many as that. Fully as many as I ever grow by feeding artificially; in fact more. After they arrive at yearlings I transplant them. But certainly you can raise in a natural pond by growing the weeds

and everything accumulating in there, and the natural food growing there, you can raise enough to take care of your yearlings without any trouble whatever, and that is the most important time. That is the time I fully agree with the paper in relation to transplanting. But I would not put out in any stream fry; I should raise them in these natural ponds until they are yearlings and then transplant them.

The question has bothered me a good deal. I have thought much about it, about trying to propagate enough in other ponds to feed the fish after they get older, and of course I have been interested in those papers which have referred to that. I have my doubts, however, of doing that upon a sufficient scale to feed larger fish. The fish are very voracious and need a great deal of food. But the fact that you can take care of the young fish, is of itself a very important question in trout culture. Make more ponds; plant the weeds and the stuff in them; put in the freshwater shrimp and the other crustacea, that will grow according to the location and the section. You can raise food for the young fish without any trouble whatever, and get your fish up to yearlings and then transplant them.

I have also experimented on raising other fish than trout; and some three or four years ago I gave the result of my experience in Lake Geneva in putting in the salmon trout. We have expended a great deal of money in Western States, in Wisconsin, Illinois, Iowa. The Fish Commissioners were very enthusiastic in the matter of taking the spawn of the salmon trout from the great lakes and hatching them and putting them into the smaller lakes with which those States abound. But I think it has been a failure all through. I made the experiment in Lake Geneva, which was a lake particularly adapted. It is of a character like the lakes of this State—Hemlock Lake, Cayuga Lake and those other lakes. A deep water lake, 150 feet deep, perfectly pure.

They have in them (the sysco) the natural food of the salmon trout, in its mature condition. And I thought it was particularly adapted to the raising of the lake trout. I pursued it for five years; putting in about half a million every year, of healthy young fry; hatched them, raised them, brought them up, and then dumped them into the lake. And I never have seen any sign of the salmon trout in that lake of any size. Not even the fry that I put in, or fish of six or eight inches or a foot long, or any size; never any sign. And the reason of it, I followed it out after a while, to my notion, it was entirely the lack of food for the young fish—for the fry. In the great lakes, in all these New York lakes, where the salmon trout is indigenous, where they have increased them by stocking, there are ledges of rocks, or reefs, about which the fish spawn. About those rocks is some small animal life, which I have never investigated to see what it is, but it is evidently something on which the young fish live until they are large enough to eat other fish. In this Lake Geneva there are no ledges, no rocks, and consequently no food for the young. Evidently every one of the young fry put in there simply starved to death. Demonstrating that it is absolutely useless to put fish into waters where they are not indigenous, unless you supply the food. That is the point on which the money should be expended in fishculture in my opinion. First find out if you can furnish the food for the young fish—and the mature fish too, for that matter. But until you can do that, do not waste any money on hatching, raising and distributing fry.

Dr. Keary—The trout that you experimented with is the common brook trout?

Mr. Fairbanks—Yes. One other idea. The gentleman said that he noticed there was abundance of freshwater shrimp in all trout streams. That is true. That is what the fish are there for, to eat those shrimps. But there are just as many good streams for growing trout

where there is no food, but which can be put there artificially; and plenty of springs and streams where there is no food but which can be cultivated there; for everything has been cleaned out, in cleaning up the landscape, and the grounds the streams have been cleaned out; they are all cleaned, there is nothing left in them. But you don't want to pay much attention to the appearance of the stream; if it is choked up and full of weeds, all the better; let them grow, then the trout will grow. You can make hundreds of trout streams where you haven't any now and where you haven't any trout because there is no food.

MR. MATHER—I fear I did not make myself exactly clear on this question. I agree with Mr. Fairbanks on this natural food business to a certain extent. But in his ponds, he cannot put in more than a certain number than that will support. At the station of the New York Fish Commission which is in my charge at Cold Spring Harbor, I have one reservoir away up the hill, where we grow watercress, and the water flows down into another one which supplies the hatchery. This lower one is between three and four hundred feet long and from thirty to fifty feet wide. We have put in as high as 15,000 fry there and we have put in as low as 8,000, every year; and the highest we have ever taken out of it I think was 5,000. In the fall we usually draw it down, in September, and get out everything that we can, and we have from one to five thousand trout that are grown upon natural food which has not cost us a cent. But if we should attempt in that water to carry it on on a larger scale, and put a 100,000 fry in there, it is a question whether we would take out any or not.

MR. FAIRBANKS—In this lower pond is there watercress?

MR. MATHER—No, not much. There is no cress in it, but there are other plants, and it is full of natural food; but we get a few fish that have not cost us any-

thing there. Now, if we should undertake to force it, we probably would not get as good results.

But I am speaking not of the little fish places in Europe, where they turn out 5,000 in the course of the year and think they are doing well. Suppose you want to turn out a half million a year. It is going to facilitate you to get food for those fish when you want it by the pound, or ten, or twenty, or fifty pounds of natural food. I don't know how to get it, and I don't think that any man does.

MR. GILBERT—I would like to say while we are on this subject, that where the food of trout can be purchased for a cent a pound, it is hardly worth while for a man to spend the time, or even employ labor to get the natural food. It will cost more than it will to buy it.

MR. FAIRBANKS—Natural food makes a great deal better fish.

MR. GILBERT—That is a question on which there are many differences of opinion. We had a legislative committee down to my place and we gave them a trout dinner, and they were all artificially fed trout. One of the gentlemen of the committee afterwards was presented with some natural fed trout. He said a few days afterwards that he preferred artificially fed trout. So there is a variety of opinions about that.

But in regard to food, I am feeding now about a thousand pounds of trout a week, my young fry of last season's hatching. We begin to feed in April, about fifty pounds of liver a day. To get natural food to supply that demand would cost a great deal more.

MR. CLARK—You are feeding the fry?

MR. GILBERT—Yes, the young fry.

MR. CLARK—That is, year old?

MR. GILBERT—No, the young fry of last winter's hatching.

MR. CLARK—A year old last spring?

MR. GILBERT—No; an inch and a half long; fry hatched in February.

MR. CLARK—How many have you?

MR. GILBERT—About half a million. So in order to raise more, you will require too much natural food; I don't think it could be secured by any natural means.

MR. FAIRBANKS—You can do it with fifteen or twenty natural ponds, if you have got the space for them, one hundred feet in diameter. You can run your water from one pond to the other.

MR. GILBERT—A man has not the facilities.

MR. FAIRBANKS—I was going to suggest to Mr. Mather, he has one pond there and runs the water from that into another. If you have got the room to make half a dozen of these ponds you can raise just so much more fish in them. And your natural food will take care of the fry until they are a year old, probably.

MR. HOXIE—In regard to the quality of the fish, whether fed on liver or natural food. I will just tell you a story. We raise artificial trout and we have also brook or wild trout. I have been in the habit every spring of sending to a friend a box of trout all cleaned and packed in ice, early in the spring, as early as April. Well, the gentleman wrote me that he had received the trout and they were very fine, but he did not think they were quite up to wild trout. Perhaps a couple of months afterwards he and his son were up to my place fishing. I said: "Mr. Hazard. I have got a nice joke on you; those trout I sent you, I heard that you remarked they were not quite up to the brook trout, and I took particular pains to go up to the little lake and bait my hook with worms in the old fashioned way, and catch those trout." He was surprised, and said he was going to test it the first thing. He always gets a trout dinner when he comes up to my place; so he went to my pond, and got some wild trout and marked them by snicking the tail. Then he went to the other place and got some tame trout. Mrs.

Hoxie cooked them, and he set to work to test them. So his son covered his eyes and he took pieces of each, and he got the thing reversed right around, and declared that the tame trout was the finest trout he ever tasted! The artificial trout was the one he picked out for the wild trout. And he said that he would never say again that a man's taste was keen enough to tell the difference.

MR. POWELL—In regard to this question of food for fishes, being one of the Commissioners of the State, I represent and we get applications many times for five, or six, or eight cans of trout fry. The question is whether it is wise to give them so many, whether there is food enough for them. We get applications for five or ten cans where there is not enough for two. It is an interesting question which has been put to me before by correspondence from different parts of the country. I would like to have some persons who are more familiar with this question to express their views.

MR. FAIRBANKS—Suggest that the applications give you some account of the stream they are going to put the fry in, and the food that is there. If they are interested enough for five or ten cans they ought to be interested enough to give such particulars.

MR. POWELL—The people are anxious to get as much as they can for nothing. They use fictitious names for themselves and for the streams also. If we do not send what they ask for, we are abused day in and day out. Only last night I received a communication from the Senator of Lucerne County, in the State I represent, complaining that they do not get enough trout fry.

MR. FAIRBANKS—There ought to be an investigation to arrive at some sort of knowledge as to the character of the stream. It might be as well for the commission to spend half of their money in investigating the character of the streams.

MR. POWELL—The point was put before our legis-

lature. It was said that we ought to have enough power to know where these fishes go to. We are abused every day in the week, you might say, when the season comes around for these applications. They apply to the other commissioners and then to me, and all the fish go into one stream. As to the stream, the chances are there is not more than enough food in it to feed one can of trout; and why should twenty go in it?

MR. FAIRBANKS—They should not. It is a question for your commission to decide. Your commission can exact from the people who make the applications, a sworn statement, or a statement from some well known man in relation to the character of the stream, the length of it, size of it, and the sort of food there is in it.

MR. POWELL—I went to the highest authority of our State yesterday for an opinion before I came here. We have a large number of applicants who apply for trout: our blanks simply say "on a public stream," and they declare they are public streams; and so soon as they get the fish, those streams become private streams, and nobody can fish in them. It is raising a very interesting question in our State.

MR. FAIRBANKS—I would extend your series of questions a little further to get information that would be valuable to your commission.

MR. REYNOLDS—I suggest that the commission should distribute some tracts to improve the morals of the people—not to lie about a fish until they get a fish.

MR. GILBERT—I think the application should be accompanied by a sworn statement that the fish are to go into public waters. A law should be passed to that effect.

MR WHITAKER—I have been quite interested in some parts of the discussion that has just been raised. The points that have been raised are questions we all meet in our work. In our own state we have taken occasion to secure the best general results for our own work, by arming ourselves with facts in regard to the waters

of our State. Since 1885 we have conducted each summer a systematic examination of our inland waters, particularly with reference to the lakes. Each lake is examined, its surroundings, temperature at bottom, the condition of the water with reference to food, the inlets and outlets, and everything pertaining to that; many other things I cannot now remember. In addition to that, practical men are asked to recommend the fish to plant, such as they believe will exist and thrive. It has been of immense advantage to us. A rude map is drawn upon the back of the report, with the soundings noted upon it. They are bound in book form, and we have them for every year since we began. In addition to that, in a general way we familiarize ourselves with the streams of the State. So that we can tell with tolerable accuracy whether the fish that are applied for are likely to thrive and be heard from again. That eliminated, we have the same difficulties spoken of here, of people making statements in reference to the condition of their waters; whether they are open or private, that is upon every application. Wherever we find that those matters are falsified, in future so far as we can guard against it, those applications are refused. But in this way we have this advantage that we had not before we adopted a system. It is quite a common thing for a man who has a water in which he takes a pride, to have it stocked with something, he does not know what, but he wants something. We want to entertain a due regard for the success of our work, and after an examination of our reports that are filed away, if we find that the lake he applies for is filled with bass, he will apply for 50,000 brook trout to put in that lake, we will deny it, and we will say you are only putting the lamb inside the lion.

We find that in this way the results of our work have been very much improved. We shall continue to follow this plan. And as it has been said here, of course there are times when we find people who make applications

through other private parties, apply themselves for the same streams. We determine all those things ourselves. When it comes to the closing of planted streams, the only way to be done with that, is to take it to the Supreme Court of the State, because it is a conflict between the interests of the public who have planted those waters for the public to fish in, and private individuals, and the courts will settle it. And I believe they will settle it in the line that if the public have enterprise enough to stock those waters for the public benefit, they are entitled to fish in them.

Mr. James—I think all this goes to the point that in supplying fish you must supply food, and in such quantities as will let these varieties of fish survive. Then comes in the matter of finance in connection with this: Will it pay to put in a certain variety of fish without supplying that food?

It is a bad financial policy. Those who are propagating fish, who are using the food for fish for supplying the market, must necessarily go to such expense as will give these fish the requisite amount and the kind of food. But of course you have got to keep off the marauders, and only plant in such streams as will allow them to survive. There must be some streams for black bass, and some streams for bass; certain lakes for certain fish. The whole question resolves itself down to a certain circle of life. We know that food after it has passed through and been discarded by animal life, goes back into vegetable life, again to be taken up. And this growth of vegetable life supplies food again for the minute animal life, until finally that circle is completed by the furnishing this nitrogenic food for the plant. So we have a circle in this way. If we are going to propagate fish with any degree of success, we must maintain this circle of life. Those that have the supplying of these fish must ascertain what kind of food, in what quantities, must be placed in those streams or be in those streams, other-

wise it is useless, and you throw your fish away to die. Then you must remember that the quantities of food will increase with each year. You put the small fry in and they require very little animal food; but as they grow in size from three-quarters of a pound to two pounds and a half or more, the greater the demand for the food supply. Therefore that proportionately increases as you go on. The larger your fish, the greater the supply of food needed. The larger your fish are the better price you get for them in the market. So that the whole matter is a matter of circle in finance, in the propagating and feeding of the fish.

Mr. Page—There have been one or two points touched upon here, that I have some little information on which possibly may be of value. On this question of feeding the fish. Mr. Gilbert wants to know how much food it will take to feed 10,000 pounds of trout. It might be very easily inferred from Mr. Fairbanks' statement that that would depend upon the amount of water, and the size of the pond.

It happened last year at the station of the U. S. Fish Commission where I was, we raised something over nine thousand pounds of trout in a very small space of water: five ponds, eight by twenty feet, having fifty gallons water each per minute. Those fish measured from four to ten inches in length, I am safe in saying they were the largest trout of their age that have been raised in the United States. The food supply was very small, because the water was enormously rich in natural food, particularly in snails; and as you all perhaps know, snails will produce enormous quantities of eggs, and all trout are very fond of them; we allowed them to grow abundantly on those ponds and the snails propagated. The food given them was raw beef liver mixed with a mush made from ship stuff when the fry were very young; fed in the house five or six weeks on pure beef liver; then as they were put out in the pool in small quantities a little mush

was added to it until after they were five or six months old, the mush would be increased. I have gone over that cost very carefully, interest on the cost of the plant, labor and artificial food given them makes it well on to eight cents per pound of trout. To illustrate the advantage of that, Mr. Young Robinson, at Mammoth Spring, about two hundred miles from me, in Arkansas, is raising trout and is fortunate in getting fifty cents a pound for them. I hope there are no dealers present to take advantage of that. He could well afford to sell those trout at twenty-five cents a pound. I venture to state that, because Mr. Seal asks in his paper as to what it would cost to raise trout. I know it costs very much more in some localities; for instance, my friend Mr. Mather cannot afford to buy beef liver. We use it now on some forty-five or fifty thousand trout fry, fifty pounds of liver a week and about fifty pounds or seventy-five pounds of shorts.

MR MATHER—I would like to ask Mr. Page one question: If he has made any inquiries what it would cost to raise a yearling trout; or what is his opinion?

MR. PAGE—We raise our yearling trout at about eight cents per pound and turned out a little over nine thousand pounds of fish last year, or trout. Average cost of attention, food, interest on the plant, etc., is about eight cents per pound.

MR CLARK—Mr. Mather did not ask me, he asked Mr. Page that question. I would say that a short paper that I have, will give those figures, exactly what it costs to raise a yearling fish.

DR. BRADLEY—I will ask for information: I am connected with a hatchery. We hatch about from five hundred to eight or nine hundred thousand a year. We have trout, brook trout, living in the same lake with bass, and they do not eat each other up; we catch brook trout and bass out of the same lake repeatedly.

MR. WHITAKER—We avoid planting black bass and

trout in the same stream; we believe they would not thrive together, Also, there are so many streams that are well calculated for trout and are not encumbered with those difficulties that it does not seem worth while for us to attempt to run that risk. Another thing, the question of food is a question there is no sort of doubt about with reference to pond reared fish, it is worthy of consideration But in this country where nature has provided so abundantly in most of our streams at high latitudes, it is hardly worth while to entertain the question of food. The caddis and the shrimp abound in those streams and lakes.

MR. BRADLEY—I simply wish to make the point that those fish live and breed in the same lake.

MR. QUACKENBOS—I agree with what Dr. Bradley says. On Seneca Lake, N. H., we have bass and trout together. But that is explainable on the ground that they are not in the same water at the same time, consequently they have both quantities of the natural food. Those are peculiar conditions to the water. The trout are in the deep, cool water and the bass are on the surface; and I never have found trout inside the bass. I think also the bass have destroyed the enemy of the trout, namely, the perch.

MR. PAGE—My experience leads me to believe that the old bass eat the young trout, and the old trout eat the young bass.

REARING FISH FOR DISTRIBUTION.

By Frank N. Clark.

At the twentieth annual meeting of the American Fisheries Society held in Washington, D. C., in May, 1891, I read a short paper on the rearing and distribution of trout from the Northville Station, giving the plan pursued, and some of the results attained. The members of the society present at that meeting will remember that the subject brought out quite a discussion concerning the practicability and feasibility of rearing fish for distribution. One of the arguments introduced against the work was the expense, some thinking the outlay would be so much greater than in the case of planting fry; others that the trout accustomed to liver would not adapt themselves to other food. At that meeting I promised to give some figures and facts relating to the expense of rearing trout to the age of one year at the Northville Station. It must be borne in mind that the food used at this station for feeding fry is wholly beef's liver, bought from the slaughter houses in Detroit and shipped by express to Northville. For the years 1890 and 1891 we reared and distributed 250,000 yearlings; about one-half of them being lake trout and requiring at least one-half more food than brook, Von Behr, or Loch Leven trout. The cost of the food for this lot of fish was $740.00, making the cost for food per 1,000 $2.95. The cost for labor based on actual time was $600.00, or $2.40 per 1000. In addition to this amount there should be added about $3.00 per 1,000 for expressage, draying and superintendence, making a total cost, when ready for distribution, of $8.35 per 1,000, or less than one cent each for yearling fish, and with facilities for rearing four times as many the cost as to labor would be much less per 1,000.

Not only is the arguments from figures, strongly in favor of yearling plantings, but those drawn from well-

known facts also speak with no uncertain sound; for instance: the condition of fry when planted is such that they must have food at once or they perish, while on the other hand the yearlings are in condition to go without food for a considerable length of time. Also one of the greatest losses suffered in planting fry is their being devoured by larger fish, which loss in planting yearlings we do not find as great. To test this difference, I placed 100 fry in a tank 8 feet long, 2 feet deep and 18 inches wide, containing twelve yearlings; in another tank of same dimensions, I placed twelve yearlings with six three-year old trout, this for the purpose of noting how soon each would disappear as prey. The fry were all all gone in six hours, while in the tank where yearlings were with the three-year olds, only two were gone the second day. Remember, please, that our argument rests upon actual experience and not theory.

Another argument we have to meet is regarding the matter of distribution, and we can say, in distributing yearlings to-day, we have no more difficulty in transporting them than we do fry. In our distribution this last winter, by making fourteen trips with the car and carrying 80,000 trout from two and a half to seven inches long, there was an actual loss of 1,738, and of this loss 938 occurred on one trip in which some accident occurred with the tanks, making a loss of about two per cent. This clearly answers the question as to transportation. Can the distributers of fry inform us of the actual number planted or the actual number lost in transit?

The work of planting yearlings is no guesswork, as the fish are counted into the tanks when put aboard the cars and counted out when planted, the captain of the car receipting for the fish and then again having the applicant receipt to him for the actual number planted.

An objection urged against planting artificially fed fish is, that when turned into waters to be stocked, they are naturally looking for the food they are accustomed

to and will not readily take the live food that may be in the stream. Has any fishculturist ever cast the fly in a pond of large fish that have been fed artificially and been unable to get a rise, or has he thrown grasshoppers or in fact any live food of whatever nature but it would be readily taken?

If it could be proven—though it cannot—that natural food is indispensible to the rearing of yearlings for distribution, then under circumstances that are favorable, the food for growing fish may be bred with as much care as is used in breeding the fish, and undoubtedly with far less expense than in feeding liver. This, however, would naturally require a large area of ponds and a large supply of water.

With the work of procuring eggs, laying them down in the hatchery and turning out the fry, we have long ago passed the experimental stage and have arrived at the practical side of the question with the salmonidæ. It only depends on the question of parent fish as to the number of fry to be hatched; neither does it require a scientist to do this branch of fishculture work, but a good, practical man. Therefore, with the rearing of trout to-day, the principal question that should occupy the minds of advanced fishculturists is: what should be used for food and how to procure it.

Every observing and thoughtful fishculturist knows that many of our inland lakes have been planted with hundreds of thousands of whitefish fry and only a very few have been stocked. If we raise the whitefish fry to be one year old and plant them in these lakes, is it not possible and probable with the results before us, that we may be successful in stocking many more bodies of water than the fry work has accomplished? At any rate, is it not worth the trial? Experiment by practice is part of a fishculturist's work.

One of the proposed improvements at the Northville Station is that of constructing a rearing pond for white-

fish and furnishing them with natural food from the creek. And we have every promise of success in such an undertaking.

In conclusion, I cannot refrain from expressing my deep solicitude concerning this question, for more is dependent upon the successful and increased planting of yearlings than even practical fishculturists think for. To my thinking, much of the future of fishculture is dependent upon it, and I trust that all present will enter heartily into, not only a discussion of the question, but also a practical testing of it.

At its conclusion, Mr. Fairbanks said: What do you find the natural food of the young white fish to be?

MR. CLARK—I did not say I had found it. I think the food is in the water. I think the article of Professor Forbes enters into that subject more thorougly than I could. He shows us what the natural food is.

MR. MATHER—What does your liver cost you at your hatchery?

MR. CLARK—Three cents a pound for beef liver.

PLANTING FRY VS. PLANTING FINGERLINGS.

BY JAMES NEVIN.

Mr. President and Members of the Fisheries Society:

For the past few years there has been considerable said by some prominent fishculturists, which has been taken up and discussed by the press against the planting of small fry in the streams; and that much better results will be secured if the fish are kept in the hatching house or reared in the ponds until they are some six or eight months old, and planted in much smaller numbers.

There are several States in the Union which have been engaged in fishculture and planting fry long enough to know whether their work has been successful or not.

I see by the *Detroit Tribune* of the issue of April

27th, that Mr. Clark of the Northville Station, in an interview with the reporter, made the statement that he would rather have 100,000 fingerlings than 5,000,000 fry to plant in the public waters, as the 100,000 fingerlings will bring forth better results. If Mr. Clark's statement approaches anywhere near the realms of accuracy or is approximately correct, I am forced to the conclusion that the States of New York, Pennsylvania, Michigan and Wisconsin must have a lot of idiots in the form of fish commissioners, looking after their piscicultural interests, as the 100,000 fingerlings can be reared and distributed for about one-third of what it costs to run a hatchery that handles 5,000,000 brook trout fry. The several governors of these States ought to have their attention called to this matter so that they could overhaul the commissions of their respective States for allowing such wasteful extravagance in the use of the public money placed in their charge.

I claim that we can stock a stream with fry if they are properly planted in the stream or some small rivulet tributary to it; and that there will more fish live and thrive in the wild stream than Mr. Clark or any other fish-culturist can raise in the hatching house.

If you wish to make a success of planting fry you have got to take great care in planting, and get them well up to the head waters. It is very seldom that you will find a stream but what has some spring tributary to it, and in these rivulets or springs, we always recommend the applicant to plant the fry. Some people are careless in this regard and will, for convenience sake, plant the fish at some road bridge crossing the stream. Nine times out of ten there is a large pool under the bridge, and at the season of the year when the fish are planted, the large fish seek those pools. Mr. Clark's idea is that his fingerlings are large enough to take care of themselves, but we all know the size of a trout when six months old—just large enough to

make nice bait for the larger fish—and in nine cases out of ten, his fingerlings are dumped out at some bridge, and the consequence is the little fellows, having been confined for so long a period and not knowing what it is to have an enemy, become an easy prey to the other fish. In case the fry, which has not lost the natural instinct of evading enemies, is planted near a bridge, they at once dart off to some stone or other convenient and suitable hiding place for cover, and I am firmly of the belief that fry planted in a pool with larger fish will have a much better chance of living to try the skill of some clever manipulator of the rod and line, than fingerlings would have under the same circumstances.

Some five years ago we planted 400 two-pound lake trout in one of our lakes at Madison. The following morning after the fish were planted, four of those same fish were brought to Mr. Dunning, the President of our Board, having been taken from the mouths of pickerel speared during the night; and I am of the opinion that not one of those fish lived twenty-four hours after they were set at liberty in the lake, and that they all became the prey of other fish. It was like placing a lamb in a lion's den for safekeeping.

The success of the Commissioners of Fisheries of the Badger State in stocking the streams of the commonwealth with brook trout fry, has been fully demonstrated. Brook trout were not known to exist in the streams in the central portion of the State until the Fish Commission was inaugurated, and the commissioners began planting fry; and it is in this section of the State that the commission receives the most credit. Here are some of the finest stocked trout streams there are in any State in the Union, and in a section of country where the streams are fished by thousands during the fishing season. I see by the *Milwaukee Sentinel* of May 11th, that one man took 7,000 brook trout out of one of these

streams alone last season. It was reported through the press that 5,000 brook trout were taken from the streams in the vicinity of Sparta, Monroe County, the first day of the open season this year.

It seems to me if the "Badgers" had to depend on my friend, Clark's plan of stocking a stream with from one hundred to five hundred fingerlings, that they would go fish hungry after the first day's fishing for the remainder of the season or until such time as the stream was replenished.

The people of the State of Wisconsin are well satisfied with the results obtained by planting fry. The only trouble is we cannot hatch enough of them to supply the demand, as Wisconsin is fast becoming a great resort for summer tourists during the fishing season.

I hope that the next annual meeting of the Fisheries Society will be held in Chicago, and at a season of the year when all those who are engaged in fishculture will be able to attend. Those who may have time and wish to take a short season of recreation and enjoy a few days' fishing, I will take pleasure in accompanying them to some of our famous trout streams, that they may view for themselves what has been accomplished in our State by stocking the streams with fry.

I enclose herewith a letter from the Hon. J. S. Bugh, County Judge of Waushara County, which speaks for itself for the success of stocking the streams of our State with fry. If we thought it necessary at this late day in the work of fishculture to offer further proof of our success in stocking streams with fry, we could furnish a thousand just such letters:

WAUTOMA, WIS., May 17th, 1892.

MR. JAS. NEVIN,
Supt. of Fisheries,
Madison, Wis.

My Dear Sir:

I have received your letter of the 14th inst., in which you ask me, first, to give you "an estimate of the num-

ber of brook trout taken from the streams of Waushara County, with rod and line during the past year, or years, since trout were first planted in those streams."

If you had asked me to enumerate the leaves on the trees, or the stars in the sky, I could as easily give you the number. When you understand that in this county there is the White River, the McCan Pine River Willow Creek, Rochacre Ten-Mile Creek and many other streams with their innumerable branches, all trout-bearing streams, and fished by men, women and boys here and coming here from all over the State and even from as far east as Boston, you will readily see how impossible it is to even approximate the number. The estimate might be made in *tons*, but not in numbers.

Your second question, "whether trout were known to exist in streams in this county before being planted by the commission?"

I have heretofore assured you that there were none, and I now repeat that having lived here for over forty years and hunted and fished everywhere in this and adjoining counties, they could not have existed unknown to me.

I wish to say to the commission that no one thing has brought this county into notice and advertised it so much as our trout streams. Sportsmen who come here to fish all say, that, taking all things into consideration, the advantages of civilization and freedom from the annoyance of flies and mosquitoes, it is excelled nowhere in the United States.

Should be pleased to have you and President Dunning come up and see us.

Truly yours, J. S. Bugh.

When the paper was concluded, Mr. James said: I don't know that we come fully under that category. We have been engaged in a very hard work there, to try and keep people fishing out our streams, who have with wires and every conceivable arrangement endeavored to clean them out. We have now laws that will protect us some-

what; we are cleaning out the ground, and soon we will put such fish in such streams as we think will not interfere with one another in the way of devouring each other. We are aiming to accomplish this very object of bringing about a large supply of fish in our different streams. We do plant them as far as we can get into the springs. We send them off as far as railroads will carry them, and then send carriages up as far as we can and deposit the fry. We have as yet held on to the fry business. Mr. Ford will bear me out, I think, that our shad supply a few years ago ran down to sixty thousand a year, and I think last year it was in the neighborhood of three hundred thousand to four hundred thousand catch. So in our propagating the shad as we do there, by sending them up the river, we certainly are increasing the supply of shad in our Delaware River.

PLANTING TROUT AS FRY OR YEARLINGS.

By Fred Mather.

Mr. President and Gentlemen:

In the last report of this society, pages 11 to 13, this question was discussed in a small way, neither side having any figures to show the cost of feeding and planting a trout which was a year old. I am quoted as saying: "I do not believe that it is economy to raise trout" [for distribution] "to be a year old," and that belief has been confirmed by subsequent experience. The advocates of planting yearlings have had an inning and have ventilated their views in the newspapers and periodicals, but the other side has not been heard from, and, if I am not mistaken, this opening gun from our line will be followed by others of larger calibre. We believe that the best results will be had from planting trout as fry and will essay to prove it.

If a man wishes to plant an orchard he would like to

have trees that will give him a crop at once, and if he would stock a stream he naturally wishes yearling fish; hence the scheme of feeding trout until they are a year old commends itself to the anglers and also to their journals, but what they want and what we can afford to give them are different things. The nurseryman will give you several small trees for the price of an older one, and the fishculturist can give you a hundred, or more, fry, cheaper than he can raise and deliver you a yearling trout. That the yearling is worth many fry is true, for it has escaped a class of enemies that can only kill smaller fish, but the kingfisher can still take it, and does. I will not consider the question of the ability of a pond-fed fish to take care of itself, for it may be able to do so, and I propose to treat the subject squarely and strictly on what I believe to be its merits.

At the last meeting of this society, it seemed as if my position was unsupported to any extent, and this was not encouraging to one whose only object was the general good of fishculture, but months afterwards letters of approval incited an experiment in the cost of feeding young trout and a consideration of the expense of planting them; but it was not until the first of January last, that my foreman received orders to weigh and record the food of 16,300 brook and brown trout, the hatch of the previous spring. The record gives date, pounds of food, temperatures of air and water, and remarks on weather, etc. It covers the months of January, February and March, 1892, ninety-three days, on three of which we had no food. If it be said that these fish, so near a year old, would consume more food in the last quarter, the record shows that on twenty-three cold days the fish were not taking much food, ranging from four to eight pounds of horse meat, against fifteen or twenty pounds on other days.

During the previous quarter, October to December, I have the word of the man who cut the meat, that the fish took more food; for we have little cold weather on

Long Island before Christmas, and the record shows that the taking of food was influenced not only by the temperature of the water dropping below 40 degrees Fahr., but also by the temperature of the air and the atmospheric conditions. Therefore I am disposed to take this, the last quarter, as a fair estimate of the consumption of food during the year, for we started in with 25,000 fry which fed along from March to nearly the last of May, when the mortality began, the weaker ones died, and there is a great waste of food when so finely chopped as it is necessary to be for the "babies."

Horse meat has been spoken of and a digression may be pardoned to say that during my twenty-four years' life as a fishculturist, the question of the best and cheapest food for trout has been the leading one. Beginning with hen's eggs, which is the worst of all, the usual beef's liver, lights (lungs), heart, maggots, mosquito-larvæ, soft clams, *mya asenaria*, and salt water mussels, *mytilus edulis*, have been tried until, in November last, a man who kills wornout horses for their hides, bones and dog-meat, was found who delivers us clean, sound muscle, free from bone, of horse, mule, or cow that died in calving at the uniform price of four cents per pound at the station, and it is the best food for trout, and the cheapest that we have found. At this station beef livers from New York averaged, with express charges, seven cents per pound, *i.e.*, they cost fifty cents each and averaged ten pounds apiece, and the freight on the box cost forty cents whether containing one or three, and the supply was uncertain.

To resume: During the quarter mentioned we fed 16,000 trout, as follows:

January, ...	328½ lbs.
February, ...	376½ "
March, ...	435½ "
	1,140½

This, for ninety days, would equal 12.66 pounds per day, which at .04 cents per pound would cost a trifle over .50½ cents per day, or $184.00 per year for the 16,000 fish.

Divide this and it gives $11.55 per 1,000 fish.

Add to this the transportation. One man can take care of ten cans of fry for twenty-four hours, and each can will carry 5,000 fry or 30 to 50 yearlings, according to size.

Say, for instance, that you have 1,000,000 trout fry to plant. This will require one man for twenty days if he can take them in lots of 50,000, in ten cans of ten gallons capacity, each. Without counting railway fares his daily expenses, say $3.00, and his pay, say $2.00, would equal about $100.00 for the whole. Now keep this fry for one year and if you have good luck you may have 600,000 to plant. From thirty to fifty of these is all that can be carried in a can, and ten cans is as many as a man should be asked to care for on a trip of twelve to twenty-four hours, or 500 at one time, at the largest figure. This would require twelve men for one hundred days, and again throwing out railway transportation, would cost at the low average of $4.00 per day. per man, for wages and expenses, the sum of $4,800.00 and I defy any man to prove that the results of feeding trout to be yearlings, and then planting them, would be in any sort of proportion to the expense of food and transportation, which, added together would make a grand total that would be appalling to States with small appropriations.

Let us say that one yearling is worth ten fry, which has not been proven, and then compare the expense! Let us plant fry in sufficient numbers to allow for all losses and not waste our means on planting yearlings, a new notion which has been loudly heralded as a grand success but which cannot be proven to be so.

It has somewhere been stated that the U. S. Fish Commission had stocked some far Western Stream with trout

fry for years and no good results followed; a year or two ago some yearlings were put in and lo! the stream now affords good fishing! If fry cannot live in this stream we might ask how the stock is to be kept up? By planting yearlings each year when their progeny cannot live? Surely such a stream is not a good stream for trout and should be abandoned.

That those who have streams to be stocked will clamor for yearlings instead of fry is to be expected. They would like two-year-olds also, and if we would give them our old three-pounders they would be very happy; but, they should apply for their two-year-olds just two years before they need them, and give us twelve months to produce yearlings on natural food in their own streams without expense to the state.

When we count the cost of food, attendance and planting, with incidentals, such as ice, extra help, etc., it will be found that a yearling trout will have cost from six to ten cents more than it would if planted as a "baby" the year before. Of course the item of transportation is one that cannot be accurately figured for obvious reasons. A man may be gone from half a day to three days with ten cans of fish, costing from two to fifteen dollars for his labor and hotel bills, exclusive of railway fares, and the planting of yearlings cannot, it seems to me, begin to compensate for the great cost of rearing and planting them. The assertion has been made that it is the best method, and this has been repeated and reiterated until many people believe it. There are but few men in the country whose practical experience renders them competent to speak on this question, and I am assured that an overwhelming majority of them are in favor of planting fry.

N. Y. Fishery Commission,
Cold Spring Harbor, New York, May, 1892.

I append the records, mentioned, as received from the man who fed the fish.

FOOD CONSUMED DURING THE MONTH OF JANUARY, 1892, BY ABOUT 16,000 BABY TROUT HATCHED MARCH, 1891.

		Temperature.		
Date, 1.....	Pounds, 18	Air, 56	Water, 45	Fish feeding good, fed four times a day.
" 2.....	" 18	" 52	" 48.....	" " " " "
" 3.....	" 15	" 38	" 47.....	Same, colder, fish dropped off feeding.
" 4.....	" 8½.....	" 19	" 40.....	Water colder and cloudy, fish feeding badly.
" 5.....	" 12	" 19	" 40.....	Fish fed between the hours of 8 A.M. and 5 P.M.
" 6.....	" 4½.....	" 28	" 40.....	Heavy snow, fish feeding poorly.
" 7.....	" 12	" 22	" 39.. ..	Weather clear, fish feeding better.
" 8.....	" 11½.....	" 10	" 39.....	Fish consumes more food from 12 M. until 4 P.M., when the water
" 9.....	" 12½.....	" 18	" 42.....	is down from 39 to 40 degrees Fahr.
" 10.....	" 10	" 18	" 39.....	Water cold, fish not feeding very good.
" 11.....	" 10	" 28	" 39.....	" " " " "
" 12.....	" 15	" 34	" 42.....	Clear, fish feeding very good.
" 13.....	" 13	" 38	" 44.....	" " "
" 14.....	" 16	" 54	" 48.....	Warmer and clear, fish feeding good.
" 15.....	" 8	" 32	" 44.....	Snowing, fish feeding poorly.
" 16.....	" 4	" 16	" 38.....	Water cold and cloudy, fish feeding very bad.
" 17.....	" 9½.....	" 4	" 36.....	Clear, fish feeding better.
" 18.....	" 13½.....	" 30	" 42.....	Temperature of air and water taken at 7.30 A.M.
" 19.....	" 13½.....	" 44	" 44.....	Clear and warm, fish feeding quite good.
" 20.....	" 4	" 14	" 38.....	Cold all day, fish feeding bad, cloudy.
" 21.....	" 8	" 10	" 38. ...	Clear, fish feeding better.
" 22.....	" 12	" 12	" 39.....	Trifle warmer, fish taking more food.
" 23.....	" 13	" 30	" 44.....	Refuse netted from ponds every day.
" 24.....	" 10	" 26	" 40.....	Cloudy and some snow.
" 25.....	" 12	" 30	" 42.....	Weather fine, fish feeding better.
" 26.....	" 3	" 10	" 40.....	Blustering and cold, fish feeding very bad.
" 27.....	" 00	" 04	" 35.....	Ponds frozen over, could not feed fish.
" 28.....	" 7	" 10	" 36.....	Ponds clear of ice, fish feeding fairly.
" 29.....	" 15	" 20	" 44.....	Warmer and clear, fish feeding good.
" 30.....	" 12	" 30	" 40.....	Blustering and some snow.
" 31.....	" 8	" 34	" 38.....	Cloudy and blustering, fish feeding badly.
	328½ lbs.			

FOOD CONSUMED DURING THE MONTH OF FEBRUARY, 1892, BY ABOUT 16,000 BABY TROUT HATCHED MARCH, 1891.

		Temperature.		Remarks—Mention any cause for not Feeding.
Date, 1	Pounds, 12	Air, 26	Water, 40	Warm and some rain, fish feeding fairly.
" 2	" 16½	" 34	" 42	Warmer and some rain, fish feeding very good.
" 3	" 7	" 36	" 42	Sorted and sized fish, fish wild, not feeding good.
" 4	" 14	" 26	" 40	Fish more at home in their new quarters, feeding better.
" 5	" 16	" 24	" 41	Clear, fish feeding very good.
" 6	" 8	" 18	" 38	Water cold and some ice in ponds, fish feeding badly.
" 7	" 12	" 18	" 38	Moderated by noon, fish feeding better.
" 8	" 14	" 34	" 42	Finished sizeing fish, weather warm and clear, fish feeding good.
" 9	" 14½	" 32	" 42	Fish would have taken more, but are getting short of food.
" 10	" 16	" 40	" 40	Weather warm and clear, fish feeding good.
" 11	" 10½	" 30	" 42	Snowing, fish not feeding so good.
" 12	" 13	" 20	" 38	Weather cold but clear, fish feeding fairly.
" 13	" 5	" 8	" 37	Blustering and cold, fish feeding badly.
" 14	" 13	" 10	" 38	Moderated by noon, fish feeding fairly well.
" 15	" 16	" 32	" 42	Warmer and clear, fiish feeding very good.
" 16	" 14	" 18	" 38	Cold but clear, fish feeding fairly.
" 17	" 11½	" 12	" 38	Cold and part of the day cloudy, fish not feeding so good.
" 18	" 14½	" 14	" 38	Very moderate by noon, fish feeding better, clear.
" 19	" 14	" 20	" 39	Fish would have taken more, but the food was fat and stringy.
" 20	" 15	" 36	" 41	Warm and misty, fish feeding good.
" 21	" 15	" 32	" 41	Warm and some rain, fish feeding good.
" 22	" 18	" 34	" 42	Warmer and most the day clear, fish feeding very good.
" 23	" 17	" 32	" 41	Warm and clear, fish feeding very good.
" 24	" 18	" 34	" 42	Cloudy and warm, fish feeding very good.
" 25	" 4	" 34	" 42	Cleaned out ponds, water low and muddy, fish did not feed.
" 26	" 5	" 36	" 44	Finished cleaning ponds, water low until night, fish not feeding good.
" 27	" 14	" 36	" 44	Warm and clear, fish feeding good.
" 28	" 13	" 20	" 40	Colder and cloudy, fish feeding fair, some snow.
" 29	" 16	" 28	" 40	Warmer, fish feeding good.
	376½ lbs.			

FOOD CONSUMED DURING THE MONTH OF MARCH, 1892, BY ABOUT 16,000 BABY TROUT HATCHED MARCH, 1891.

		Temperature.		Remarks—Mention any cause for not Feeding.
Date, 1.....	Pounds, 11	Air, 30	Water, 40	Blowing and stormed all day, fish not feeding very good.
" 2.....	" 8	" 20	" 38.....	Blustering, cold and cloudy, fish feeding badly.
" 3.....	" 9½.....	" 22	" 38.....	Blustering, cold and cloudy, fish not feeding good.
" 4.....	" 12½.....	" 30	" 39.....	Moderated by noon and clear, fish feeding better.
" 5.....	" 16	" 34	" 41.....	Warmer and clear, fish feeding good.
" 6.....	" 15½.....	" 30	" 41.....	Moderate and clear, fish feeding good.
" 7.....	" 18	" 40	" 42.....	Warm and clear fish feeding very good.
" 8.....	" 17	" 30	" 44.....	Warm and some rain, in spite of rain fish fed good.
" 9.....	" 24	" 36	" 44.....	Warm and very fine, fish feeding good.
" 10	" 21½.....	" 46	" 45.....	Blustering and cloudy part of the day, fish feeding very good, some rain.
" 11.....	" 16	" 20	" 43.....	Blustering and colder, fish feeding good.
" 12.....	" 10	" 34	" 40.....	Short of food.
" 13.....	" 00	" 24	" 40.....	No food.
" 14.....	" 13½.....	" 28	" 39.....	Blustering and cold, fish feeding fairly well.
" 15.....	" 15	" 30	" 39...	Some warmer and clear, fish feeding better.
" 16.....	" 14	" 20	" 39.....	Snowed all the forenoon, clear in the afternoon, fish feeding fairly.
" 17.....	" 15	" 24	" 40.....	Some warmer, fish feeding fairly well.
" 18.....	" 9	" 20	" 40.....	Snowed and cloudy all day, fish not feeding good.
" 19.....	" 15½.....	" 26	" 40.....	Clear, fish feeding better
" 20.....	" 17	" 42	" 41.....	Warmer and fine, fish feeding good.
" 21.....	" 15½.....	" 36	" 40.....	Some colder, fish feeding fairly.
" 22.....	" 16	" 22	" 41.....	Warmer and clear, fish would have taken more, did not have it.
" 23.....	" 18	" 40	" 44.....	Cloudy and some rain, fish feeding good.
" 24.....	" 10	" 43	" 44.....	Warm and clear, short of food.
" 25.....	" 11	" 40	" 45.....	Short of food, weather very fine.
" 26.....	" 21	" 42	" 46.....	Weather fine, fish feeding good.
" 27.....	" 19	" 38	" 47.....	Cloudy and some rain, fish feeding good.
" 28.....	" 20	" 42	" 45.....	Weather fine, fish feeding good.
" 29.....	" 9	" 50	" 45.....	Short of food, weather fine.
" 30.....	" 00	" 42	" 44.....	Out of food, weather fine.
" 31.....	" 18	" 38	" 45.....	Weather fine, fish feeding good.
	376½ lbs.			

FRED MATHER.

FRY VS. FINGERLINGS.

By Herschel Whitaker of Michigan.

Much has been said and more has been written in the last two years regarding the desirability of planting fingerling trout as against the planting of fry, as a surer and more effective means of stocking the streams of the country. The idea, like all new ones, has found ready advocates who have taken up the cry, until it has come to be believed that there is real foundation for the claim, and that it is a mistake to pursue further efforts along the line of fry planting. To those who have had experience in fishculture and are familiar with the results of the work done for the past ten or fifteen years, I think the claim of the fingerling advocates does not appeal very strongly, but with the unthinking ones it has met with more favor than it deserves or would have received upon a full and thorough investigation.

In considering this question we cannot fly in the face of past great success as the result of stocking waters with fry, neither can we disregard the fact that if plants are made of fish at a fry age we have attained the maximum of output at a minimum of cost. That the cost of raising fish to the fry age is cheap no one can deny, and that it has been eminently successful is beyond refutation. This being admitted let us recall for a moment past experience and see what has been done and what has resulted from fry plants.

No stronger argument can perhaps be presented on this point than the remarkable success attending the restocking of the shad rivers of the Atlantic Coast, which have been restored from a point of great decay to a condition where the fishing is profitable. This is emphatically the case with some of our salmon rivers, and noticably the Penobscot where the run of the salmon had almost entirely failed. The papers devoted to angling and fishing interests have shown that for the last three or four years, or

perhaps more, the salmon are beginning to return to this river, and the spring accounts of the fishing at Bangor, made daily show that the stocking has been a success beyond all question, fish being taken as high as thirty pounds weight. The salmon and shad being anadramous inhabit, the fry have had to run the gauntlet not only of their natural enemies in the streams which they frequent but of the countless enemies of the ocean where they remain for the greater part of the year. Notwithstanding this condition of things the results speak for themselves.

So much as a brief statement of what has been done in the sea coast fisheries of the country, and now let us consider for a moment the results of inland fry planting. It seems scarcely necessary in a body of this kind that I should call attention to the numerous and almost innumerable inland streams of the New England, Middle and Northern and Northwestern States which have been restored from a decimated to excellently stocked streams.

But let us go a step further. There was a fairer field for the demonstration of success in fry planting than has been afforded in my own state of Michigan, Prior to 1841 the lower peninsular of Michigan was practicably a zoological desert as far as the brook trout was concerned. Fry planting has been going on under the efforts of the Michigan Fish Commission for the last eighteen years, but it cannot be said to have been adequately done in point of numbers until the years following 1880; yet for ten or twelve years fine trout fishing has been had in more than half of the counties of that peninsula, and with the advent of this spring the number of streams opened to public fishing has been largely increased, until it may now be said that Brook trout can be had for the taking in fully two-thirds of the counties. This is in some measure true of the state of Wisconsin.

The Saranac lakes in New York furnish another evidence of the success of fry planting of whitefish under somewhat adverse circumstances, the lake in which they

were introduced being filled with their natural enemies, and yet from a small plant made in this lake about the year 1885 we learn that adult fish have been taken.

All fishculturists who attempt to keep up their stock of parent fish by raising a certain quantity of fry each year are familiar with the great mortality occuring at the period when the young fish has finally absorbed his food sac, and is ready to take the natural food provided by nature. At this time when he "rises" in search of this natural food if he does not find it he is compelled to take the artificial food prepared for him, and the difficulty of adapting his stomach to this food results in a loss which varies somewhat from fifty to seventy-five per cent. If the young trout at this period of his existence were allowed to forage for his natural food this mortality would be greatly reduced. There are streams that are well known in Michigan which have had plants of fry not to exceed five hundred in number which within three years from the time of stocking have shown up well, and to-day without further stocking afford good sport to the angler.

Within the current month there appeared in the Detroit daily paper an interview with a prominent fishculturist who took occasion to say "I believe, and against great opposition have always maintained, that 100,000 yearlings planted were more likely to live and thrive than 5,000,000 fry." Making due allowance for the enthusiasm of the interviewed party and for the natural predisposition of man to defend his pet theories, let us see where these figures would leave us.

We will start with 5,000,000 fry planted, and we will say that twenty-five per cent. perished the first year, ten per cent. the second year, and five per cent. the third year. At the end of the second year after deducting the twenty-five per cent. for loss, and estimating the number thus left to be composed of one-third females, which would cast on an average 250 eggs apiece, there would be added to the stock 281,250,000. Estimating that there will be a

loss of seventy-five per cent. of this number we have left 70,312,500. At the end of the third year we would have 1,068,750 spawning females casting on an average 450 eggs each amounting to 480,937,500. Deducting from this amount seventy-five per cent. for loss, and we have left 120,234,375. These added to the original plant, after having deducted therefrom for loss on the original plant twenty-five, ten and five per cent. for the three years, and we have left as the result of a 5,000,000 plant 193,753,125.

Now let us take 100,000 yearling trout: At the end of the first year after planting we deduct ten per cent. for the mortality in the adult fish which leaves us 90,000. Of this number one-third being females, we would have 30,000 spawning fish which would cast on an average 250 eggs apiece. This would give us 7,500,000 and deducting seventy-five per cent. for mortality we have left 1,875,000. At the end of the second year after planting after having deducted five per cent. loss for adult fish, 85,500. One-third of these being spawners, will cast 450 eggs, each amounting to 12,825,000. Deduct from this amount seventy-five per cent. for mortality and we have left 3,206,250. At the end of the third year after having deducted five per cent. for loss we have left 81,225 fish. One-third of this number being females will cast on an average 900 eggs to each fish amounting to 24,367,500. From this amount deduct seventy-five per cent. for loss, leaving 6,091.875.

At the end of the third year we must also take into consideration the fry hatched from the fish hatched at the end of the first year which will have arrived at their first spawning age. This number will amount to 1,875,000. From this amount deduct twenty-five per cent. for mortality and we have 1,406,250. One-third of these being females leaves 468,750 spawners which will cast 250 eggs apiece amounting to 117,187,500. Deducting from this quantity a loss of seventy-five per cent. and we have left

29,296,875. The above amounts added together make the total result of the planting of 100,000 yearling trout at the end of a three-year period amount to 40,551,225, as against 193,753,125 as the result of the fry planting of 5,000,000.

Considering the results, therefore, of fry planting from which practically all the results we have are due, we must assume that it has been eminently successful, and when we consider the cheapness with which this work is done it would seem that the ample success of fry planting is simply incontestable.

The President asked for discussion, and

Mr. Fairbanks said: It has occurred to me on hearing these papers that there is an opportunity or chance to harmonize the views of these people, according to the location and the character of the streams of the country in which they are located. If there is anything I can do to harmonize Mr. Clark and Mr. Mather, I will do so. In the first place, consider the question of feeding young fry on their natural food in natural ponds. That of course takes into account the matter of the cost of constructing those ponds. If the grower of the young fish is so situated, if his springs are such that he can construct these natural ponds cheaply, if he can make thirty or forty of these natural ponds of a hundred feet in diameter in which he can plant the weeds and the moss and the plants that the shrimp grow in naturally, he can feed his young trout until they are yearlings at a very small cost; the whole cost is in the original construction of the ponds. Mine are very cheaply constructed, a very trifling sum. If they are so situated that those natural ponds can be constructed and the natural food of the fry can be put in there, you can turn your fry in and raise them at a very small cost. Under such circumstances I have no doubt the yearling trout is the best one to transplant. But if he must be fed and it cannot be done cheaply, or

if it is very expensive, as in the case of Mr. Mather, then I should plant the fry by all means.

There is another important consideration which, to my notion, has more to do with it than the other. That is the character of the stream in which you plant your fish. The success in Wisconsin has been very great, as has been stated in the paper which was read. I have been familiar with that. I got the first bill passed which established a commission in the State of Wisconsin, some fifteen or sixteen years ago. The streams in Wisconsin are much larger and deeper and better streams to plant fry in than are the streams in New York and Pennsylvania or any of the New England States, which are small, babbling, shallow brooks, abounding with all sorts of little fish, enemies of the fry. But you put the fry in these Wisconsin streams or in the Michigan streams and the water is deeper and they have a great deal better chance; they do not have nearly as many enemies as they do in the streams of New York, Pennsylvania and New England. And in those streams I am inclined to think that a yearling trout is a better fish to put in than the fry. Of course you have got to be governed in your location by the expense; that is another element. Where your yearling trout costs ten cents, as in the case of Mr. Mather, there is no question about it, the fry is the cheapest, and you will get better results from it. But if you can feed the fry on natural food and it does not cost you anything up to a yearling, then the yearling is the better fish to plant. My yearlings do not cost me anything. I give them absolutely no attention whatever, in these natural ponds that I speak of, and where you can construct those natural ponds—and there are very few places I think where you cannot—I think even where Mr. Mather is he can construct a dozen or so.

Mr. Whitaker—Are those private ponds or feed pond for other streams?

Mr. Fairbanks—No, they are private ponds. But I

have no doubt where you have hatcheries, where the land is right, the formation is right, and you have water enough to construct your natural ponds at moderate expense, then you can raise your fry up to a yearling at a very trifling expense, and in that case yearling planting is the best. But you cannot lay down inflexible rules, because it depends so much upon location and expense and other causes.

MR. CLARK—I do not wish to occupy the time of the members on this very much discussed question, because there has been so many things brought up here it seems to me, only to be answered by another paper another year. As to the personal attacks upon me, I have nothing to say, any further than this, the quotation as it has been remarked here by one paper—which is a personal attack, for it uses my name—I made a statement that I believe 100,000 yearlings were better to stock streams that 5,000,000 fry. And I still believe it. I can show quotations from eminent men—more so than myself—I think if you will look at the reports, our late Professor Baird made a more rash statement than that. We have already had one paper read here to-day by some gentleman from England, I think; the statement in it is broader than mine, so that my statement is not the worst that ever was. Here are a few figures that Mr. Mather gives us in regard to the cost: He makes out that fry, or yearlings, rather, cost ten cents a piece. I make out that they cost less than a cent apiece. Perhaps from my paper you did not just exactly understand how I arrived at that. I took two years. There was no guesswork about the cost of my business, that I know. I did it on the same principle that your bank examiner of the State calls for a report, and takes every book. You simply have got to give him a report of what it is. The figures for food of those two years were taken from the books and accounts of the U. S. Fish Commission, and the books are open for inspection; that you will know.

The cost for food was taken. I did not commence two years ago to keep track of this, but I simply took the beef liver bill; and of course you know, and every other fishculturist knows, that for the first two or three or four months, at least a half of that is wasted. I did not, as brother Mather says, weigh this food; I simply took the bills; that is the way I arrived at what it cost. Then the amount of labor was as I have given you. If my men were called off, down went the pencil, so much time on the fry, and it was the actual time in regard to it.

There is one point in regard to yearlings that I wish to state as near as I can. It is possible that some of the U. S. Commission men can help bear me out in this. Two years ago last August, I think it was, there were 80,000 yearlings—they were well-grown fish—were taken to the Yellowstone Park by the U. S. Fish Commission. As I understand to-day from very good authority, the Yellowstone Park streams and lakes are well stocked with trout; and they did not have the trout there before. It is well stocked with good fish.

MR. PAGE—I think they have succeeded so well that they have very young fish there also.

MR. CLARK—Good results from yearling planting. On the basis of what those fish cost me, there would be probably $800. and you count the expense of getting them on the ground, and the men's time that distributed them, and all that, probably would be $400. more, something like that, I can't give you accurate figures. Mr. Mather says a hundred fry can be raised for less money than it costs to raise one-year old trout. I have not figured that out; it would seem as though that is not right, but I have not figured it out.

MR. BOWMAN—There are some facts that these gentlemen can all agree upon. It certainly is a great benefit to plant either fry or yearlings. I think it is a conceded fact by everybody that yearlings are better than fry. It is a simple question of which can be produced

the cheapest and which will produce the greatest result for the least money.

This question of food is a particularly interesting question. Caledonia has been alluded to and the Spring Creek at Caledonia. And I think there is no stream on the face of the earth that produces the amount of natural food for trout that that stream does. It has a great variety of plants. If you pick up a handful growing in any part of the creek, it will be alive in your hand. Where you have a stream of that kind, and where these mosses and those plants can be set in the stream which will produce that amount of food, of course you can rear a limited number of trout to a year old at a very little expense. We have raised for years at Caledonia—for the last five or six years—anywhere from five to ten to fifty thousand yearling trout. We have not adopted the plan of the gentleman from Wisconsin. But we have raised in ponds four feet wide by twelve feet long a stream of water running through, feed them upon liver, chop it and put it throngh sieves until it is reduced to a pulp; and to-day at the ponds at Caledonia we have ten or fifteen thousand yearling trout, we have pursued a policy of distributing both, although the greater amount have been distributed as fry. What we want is best results for the smallest amount of money. That ought to be the object. Produce the greatest results both in trout and food for the smallest amount of money. That has been our aim.

Now the results obtained. One result for instance: shad were never known upon the Pacific coast until that coast was stocked by the Commissioners of the State of New York; and I understand that shad to-day are abundant upon that coast, and sell, I understand, from ten to fifteen cents apiece. That stocking was done with fry, fry were taken from our coast to the Pacific coast by Seth Green, under the direction of the Fish Commission of this State, and were turned loose on that coast where

there were no shad before. The result is you have abundance all over that country.

As has been alluded to, the Hudson River has been stocked with fry, and the Connecticut River has been stocked with fry. After a certain length of time the Connecticut River ceased to be stocked and the Hudson River continued to be stocked, and the result has been that we have found fine fishing every year in the Hudson River, while the shad have almost disappeared in the Connecticut River, and yet the two rivers are only a few miles apart. This has been the effect of stocking with fry. Take the Chatauqua Lake, in which there was never any bull head until they were put in by the New York Commission. They are a very much abused fish, for in good water it is an admirable fish. To-day anyone can go out with a hook and line, into Lake Chatauqua and can take a good basket in a very short period. That was stocked by putting in the adult fish. Of course the bull head and the black bass are different from almost any other fish; they make their own spawning beds and take care of them during the process of incubation and they protect their young until they are large enough to protect themselves. Hence the New York Fish Commission have always stocked different lakes and different streams in this State by putting in the adult fish. Where you have a fish of that kind that will take care of its young, that will fight everything away from the spawn, the sucker and everything that comes to eat it up, and will take care of it until the fry take care of themselves, there is no doubt that putting in the larger fish is a decided advantage. With the trout they do differently. Trout makes its spawning bed with its tail, deposits its eggs upon the sand, the male comes along and deposits the milk and they go away and leave it. The young fry is hatched by the water going over it. As they come out, nature has provided a little sac upon which it feeds until it is old enough to search for its own food.

Air and water are usually furnished without price, but the great struggle of the animal world is to get food, and it feeds upon anything it can come to; if driven, upon its own kind even. After this sac is absorbed, this small fish immediately turns its attention to taking care of itself. The small fish or fry instinctively seek at once the upper channels—you never see fry going down stream. I can go right into Caledonia and I will find little trout wiggling up stream. I think they instinctively go up stream to get food and get away from their enemies. This is simply a question of opinion, and I think gentlemen should express their opinions fairly. I am not a believer in the fact that so many of these fry are consumed by their enemies as a great many men seem to say. Of course there must be great mortality; they have a great many enemies. So have the larger fish: you have the snake, the kingfisher and a variety of enemies, and more or less fish will be consumed. But the fact is patent, that the streams of Michigan and Wisconsin and the Adirondack region of the State of New York, have been stocked by the distribution of fry. Now, my own judgment and my own belief is, that that is the cheapest and the best way to produce the best results. We hatched at Caledonia from four to six millions of fry. To raise those to yearlings, you cannot do it on my friend's plan from Wisconsin. Perhaps there is a water that you can put in twenty or thirty pounds at the most. If I had a pond of my own and was pursuing it for my own benefit, I would undoubtedly pursue the same course as my friend; but when you pursue business on a wholesale scale, you have got to follow a different plan from where you plant two hundred thousand for your own use. I can raise any amount at Caledonia, but when you come to raise four or five millions for distribution, you have got to have something to supply the demand. And I think that is where this question turns. If you are going to raise a large number, five, six, or

eight, or ten millions to distribute over a State, I think it would be impossible to raise them to yearlings. If you want to raise a limited number, you can do it in almost any hatchery in this State. I think it is desirable. We have pursued the plan of raising every year three or four or five hundred thousand, and we raise them in these ponds. Many of you have seen them. We require a little different applications from those which many of the gentlemen here have spoken of. We ask the applicant to tell us the depth of the water, the temperature of the water, whether hard or soft, and a general description of the stream; and if we find that fifty or a hundred yearlings will start that stream better than the fry, we send the yearlings. We have done that in several instances, although the great distribution has been made by the distribution of fry to different places.

It strikes me as though the judgment of every person here is to do the greatest good to the greatest number. am glad to see this discussion; progress comes out of it. If any man can convince me, show me we can do better by planting yearlings than fry, I would stop as a commissioner and advocate the policy of never distributing another fry, but all yearlings. But I believe the best thing to do is for each hatchery to raise a certain amount of yearlings and distribute fry, put them up in the upper part of the small streams where they can take care of themselves and where they can find other food after the sac is gone. They can be transported readily up into the upper streams where they can hide. I think you will find the best results in that. I think experience has shown that the streams of a country can be stocked quicker and cheaper in that way than they can in any other. (Great applause.)

MR. MAY—I will read a couple of telegrams addressed respectively to Dr. Herschel, one from Mr. Blackford, and the other from Mr. Collins, Chief of the Department of Fish and Fisheries.

Mr. Clark—There is one little point here. Some of the members here do not know me as well as Mr. Mather does.. I do not wish it to be understood that I advocate nothing but planting yearlings. Not for a moment. It would be utterly impossible to raise them. But I mean to do as the United States Fish Commission does, last year at their carp ponds in raising shad put in there, raise what you can. White fish the same way.

Mr. Bowman—Have you ever raised a shad from young?

Mr. Clark—They have shad that are fourteen months old as I saw them, nice, clean, healthy shad, in salt water. The shad the gentlemen saw there last year, they were two inches long. Now, with shad and white fish, what I advocate is having places of that kind to keep them and then let them go out in the fall as two, or three, or four-inch fish, but not undertake to raise them all.

Mr. Ford—I have a statement to make: I have never believed that the young trout fry were always subject to danger from so many enemies, as was popularly supposed. I asked our superintendent to make a plant in a small stream that runs through our grounds at Allentown. This is what he says: "I planted the fry at the age of six weeks or about the middle of February. and visited the stream once or twice a week until April 1st. I always found the fry just where they were planted. They appeared to be doing well and growing faster than those in the hatching house planted in March or April." They all appeared to do well. I certainly do consider it the best and most economical way to plant a stream, put fry out. They have been well fed. The fry are large and strong, and able to take care of themselves. Now, I will say that the State of Pennsylvania has always put out her fry at the age of two or three months. This year we have put out over three millions young fry. We could have put out six millions; we had applications for that many, but we didn't have the fry. Again

in the River Delaware, where the U. S. Fish Commission first planted fry, they were dumped in at high water. But of late years they have been putting them up in the headwaters of the stream where the young fry naturally go. The result has been that there has been a great increase. The value of that shad taken in the Delaware River in 1881 amounted to $80,000, and in 1890 and 1891 between $500,000 and $600,000, showing a great increase and very satisfactory. I am no advocate of keeping young shad until they are large; I think putting them in ponds deprives them of their natural food.

Mr. Rogers of Nova Scotia—I have been intensely interested in the various papers to which I have listened to-day, particularly on the subject of fry versus fingerlings; and on fish food. Any knowledge I possess on the subject is entirely practical. I live in a fish country, and we have been for the last fifteen or sixteen years planting salmon. We have been conducting under the government fishculture on a pretty large scale. In Nova Scotia where I reside, many millions of salmon fry have been planted, and the results up to the present time have been very small. I am decidedly in favor of fishculture. Its possibilities are practically unlimited; there is no question about that.

I want to relate two or three facts in relation to fish after the fry planting, which will be of importance, I think. I communicated some of them some years ago to Professor Goode of Washington. He was here this morning.

I spent my childhood, my boyhood and manhood, close to a small river running into the country about thirty miles. When I was a boy we could buy a thirty-pound salmon for twenty-five cents; the river was literally crowded with fish. In process of time, across the mouth of the river, it was a common thing to see three or four hundred salmon dead, as a result of slaughter by

butchers. That ended it in a few years. Then not a fish was caught or seen in the river until a few years ago. We planted salmon fry at the very headwaters of the river. We planted them for the reason that the railroad crossed the head of the river and brought up the young fry from the hatchery; and that was their natural place; their instincts led them there to hatch their young, which takes about five months. They plow furrows in the gravel and cover them over, and the water filters slowly through the gravel, and produces the continuous slow change, and the current carries away the autumn leaves so that the eggs will not smother. They also go there to get away from the abundance of the natural enemies of their young. This river I refer to, is now full of salmon. It is the only river in Nova Scotia that I know of, and I am familiar with all the practical results of planting fry, and I attribute the success to the reason that the fry are planted where they belong. In the other rivers, they are mostly all planted down at the lower portions of the rivers. These facts cannot be disputed. I communicated them to Professor Goode.

The other fact is just this: We are in the habit of catching five or six hundred salmon in the early weeks in June and inclosing them in an inclosure and keeping them until October. We have tried to induce them to take food, but they won't touch any sort of solid food. They are there for five months. In October they have rather gained in weight than lost. What did they feed on? They took no solid food. May it not be that they get their food out of the water? This would be for scientists to determine. I have thought that the water comes down over the watersheds in the spring months, richly freighted with that vegetable property which the bird gets in the bud and the wild animal gets in the bark and you and I get in the grain. This is their sustenance, they get it in liquid form. It is certain they eat nothing. May it not be possible that the fry feed on the same?

MR. FAIRBANKS—These salmon are weighed before spawning when they come in in June, and then in October you weigh them just before spawning, the spawn having been growing all the while, growing on the food which they got out of the ocean and the water, etc. It is the increased weight of the spawn that probably makes them weigh more. After they have spawned they would weigh a good deal less.

MR. BINCOTT—I am very much pleased to see how cheap fish breeding has become; I mean to say that for the first time in my life. I have been in this business off and on for a long while. I now find you can raise trout and raise fish for nothing! And it is a miracle to me that the thing should come down to that basis. And if we can put out yearlings at a few cents a pound, I think we ought to go to work and do it. I was formerly in favor of fry; now I am in favor of yearlings by all means. For I find they can be brought up for nothing. One gentleman says nothing; one says eight cents; another says four and five cents; another says under eleven. That is the highest price. So I am decidedly in favor of yearlings. I think it would pay the United States to hire those gentlemen to show how it can be done, and buy our fish from them and stock our rivers. It is the cheapest thing I know of. (Applause.)

DR. HUDSON—I want to say this single word to correct a wrong impression of the gentleman who represents the State of New York, Mr. Bowman. He stated in his remarks that while the Hudson River was being stocked annually with shad fry, that they had ceased doing the same on the Connecticut. I have no means of knowing where that impression arose. I know it does exist, but it is not correct. During all these years that the shad has been decreasing in the Connecticut River, the stocking has been going on precisely the same as formerly, and in very large numbers. If you ask me why the shad are now decreasing where they formerly

were increasing, it is a very difficult question to answer indeed. There is no doubt about the fact that the Connecticut River being a smaller river than the Potomac, or the Delaware, or the Hudson, that it is very possible that the methods of fishing adopted at the mouth of that river may have had very much to do with the decrease of the fish. Gentlemen who are not familiar with the Connecticut River may not be aware that we have a system there which, so far as I know, cannot be adopted in any other river in the country; that is, I mean to such a deleterious effect upon the shad. The shad coming into the Connecticut River, as they approach the river come from the West generally. Whether they come from Montauk Point or through the bay from the North River and the East River, of course no one knows; but they do strike the coast of Connecticut somewhere along for a distance of ten or fifteen miles from the mouth of the Connecticut River. It should be borne in mind, that the water from the mouth of the Connecticut River does not go straight into the Sound, but makes a bend around to the right, so that nearly for ten miles around from the mouth of the Connecticut River water can be dipped from the surface of the Sound fit for drinking purposes. As the shad reaches this fresh water to go into the Connecticut River, of course they are directed towards the mouth of the river and follow along in that direction. Now I am going to allude to the effect of pounds on the Connecticut River: Those were established in 1849 along the mouth of the Connecticut River for ten miles, every few rods during that whole distance; those pounds were erected in the run at ten, thirty and forty rods, sometimes two and three miles out into the Sound, each year further and further. They were so arranged that every fish coming along from the Sound seeking the mouth of the Connecticut River had to run the gauntlet of that entire lot of pounds, fifteen, twenty, thirty of them running that distance. Those

pounds fish twenty-four hours in the day and seven days in the week. And how under the circumstances any shad ever succeeded in getting into the Connecticut River, was always a mystery to me, notwithstanding the fact that they did come in in considerable numbers. Just as soon as they have passed that gauntlet, the moment they enter the mouth of the river, they find from eighty to a hundred gill nets sweeping down into the river into the Sound, taking what shad were left from the pound. Those few shad that safely go above these gill nets, as soon as they reach Essex, which is about the upper station of the gill net, then every single station on the river from there to Holyoke where itwas possible to run a sweep net a sweep net was put; and these were so arranged as to go across the river and one follow the other as fast as possible. That fishing was continued in the Connecticut River for years until finally shad began to decrease very rapidly. In 1870 or thereabouts, after the shad hatching first began in the Connecticut, we increased the shad so rapidly, and there was such immense quantities of them that the fishermen begged us to desist, saying there is no use hatching shad you cannot sell.

But the work was continued, the commissioners believing that the proper work of the commission was to make shad cheap for the masses. As I said before, this fishing had gone on in such a way. But whether that is the cause of the decrease of the shad, I don't know. I have stated this to correct Mr. Bowman's idea. The commissioners have continued all through this time putting shad into the Connecticut in enormous numbers up to within a year or two, and the last year or two it has been continued but not to such an extent. But in the meantime the shad have come down from some four or five hundred thousand a year to about twenty thousand. For this year, as far as I recollect, the number is about thirteen thousand, as I have heard only recently.

MR. FAIRBANKS—They all increase very largely after the putting in first begins.

DR. HUDSON—Yes; though they have been putting them in very large numbers of recent years; some fifteen, twenty, thirty or forty millions every year up to about two years ago.

MR. BOWMAN—Were those brought from other places?

MR. HUDSON—Yes. The work has been going on constantly. There is another reason which has been alleged. The fishermen allege this as one reason why the shad do not come into the Connecticut, namely, the breakwater which has been built near the mouth of that river by the U. S. Government for the purpose of increasing the depth of the outflow over the bar. They claimed that the effect of that is to send the water directly into the Sound instead of to the West as formerly; therefore they think that may have thrown the shad into some other river, from the fact that further to the West towards New Haven some of the men take a great deal more than they do.

MR. BOWMAN—Can it not be that there is contamination in the water.

DR. HUDSON—As I was saying before, the Connecticut being a small river it may be more easily affected by contamination.

MR. JAMES—Of course there is a question whether any contamination has been noticed along the river.

DR. HUDSON—There never has been in regards to shad, but as to small fish there has been; carp and dace and such things, but not with the shad.

MR. FORD—The proof of Dr. Hudson's remarks has been borne out by our experience in the Susquehanna and the Delaware. In the fourteen miles of the Susquehanna within the State of Maryland there are hundreds of fishers that catch the young shad as they go down to the sea, and with the pound nets in the mouth of the river, there has been a constant and continual decrease in

the catch of shad in the Susquehanna. In the Delaware in our State, in Pennsylvania, we have laws that everybody fishing with nets after the close of the shad season in the upper streams, that protect the young fry from the fine meshed nets, which are so destructive on the other rivers.

MR. MATHER—I want to say a few more words. I had concluded not to say a word more on the question of fry and yearlings, but I must add this: I have seen it stated that in some of the streams in the Yellowstone Park or West, several attempts were made to plant with fry, which failed, and other attempts made with yearlings succeeded. Now, the question naturally arises, suppose these yearlings do succeed and spawn there, what is to become of their fry when they are hatched? They are the same kind of fry and of the same age we would plant. And it strikes me that if that is the case, if fry cannot live in those streams, and nothing but yearlings can, you have got to put in yearlings there every year or else there won't be any fish left. And as we have said something upon the cost of the fish here, without knowing what their views are, I would ask Mr. Gilbert to say what he thinks a yearling trout will cost to raise, and I will ask Mr. Hoxie to give the same opinion.

MR. CLARK—Did you make a statement that fry could not live in the streams?

MR. MATHER—I said it had been said.

MR. CLARK—How can I answer the question?

MR. MATHER—The idea is this: If you plant fry in a stream and they cannot live, and if you plant yearlings and they do live, how are you going to stock that stream if fry cannot live in it?

MR. CLARK—Will Mr. Mather point out where I am quoted as saying that I would do anything of that kind?

MR. MATHER—I do not say you said it; I say it has been said.

MR. CLARK—If I found that fry did not live in the

streams, I would not plant yearlings. If I found that the fry were eaten up by something else, I would try yearlings to see if they would live.

MR. FAIRBANKS—I would suggest that yearlings might be put into a place in a stream where food did not exist, and when they came to spawn their natural instinct would take them to the place in the stream where food existed. Just like trout go to spawn on the reefs in the great lakes because their food is there for the young. And the yearlings would naturally hunt up in the stream a place where there is some food.

MR. MATHER—About the cost of raising trout I should like to hear.

MR. GILBERT—The cost of my feed last year was about $400, and with that amount of food I raised about 30,000 yearlings. I have got now that number, and we have sold since the first day of April, 5,730 pounds of trout to the time I left home yesterday morning. Those have been raised from yearlings to two years old, large enough for the market, and also the 30,000 year old trout, all for the sum of $400 for the food for the whole year. I cannot say what part contributed to the young fry or to the yearlings or the year old fish up to two years; I do not keep any separate accounts. That does not include the cost of labor, but merely food.

MR. MATHER—What do you expect to sell your yearlings at?

MR. GILBERT—Well, we want $100 a 1,000. I would sooner sell fry for $4 a 1,000 than sell yearlings for $100 a 1,000. When you get trout a year old, my loss is not probably five per cent.; I do not know that it is three per cent. from year old to two years old. The great loss is up to four months. Although I do not know that up to the present time——. By the way, we never feed in the hatching boxes.

SALE OF ARTIFICIALLY REARED TROUT.

By W. L. Gilbert.

I have always been greatly interested in the fish and game interests of the country, and also in the passage and enforcement of all reasonable laws for the protection of the same.

I presume my father did more than any other man in Plymouth, and at his own expense, in stocking the public waters of that town with black bass and white perch. I have on several occasions restocked the only public trout stream in Plymouth with trout fry whenever I had a surplus after stocking my own ponds.

As only a small portion of the people are interested in the fish and game laws, it is always well in framing them to guard against the possible danger of having them so arbitrary as to interfere with the private rights of the people or with their industrial pursuits. We had an example of this nature in Massachusetts. Under the law the Fish Commissioners had power to lease the fishing rights in any great pond of over twenty acres to private parties, and they did so with a large number, thus taking away from the people at large the right to fish in any leased pond, under a penalty of $20 to $50 for every offense. The people stood it for a few years, and in 1884 they appeared at the State House in force and demanded and obtained the repeal of the law, and now the commissioners have not the power to lease any pond in the State.

The policy of Massachusetts, and also of other States, has been to encourage the cultivation of trout and other useful fishes as a food product, and it was for this purpose that the several States and also the United States organized the Fish Commissions, and Massachusetts passed the law of 1869, the title of which is "An act to encourage the cultivation of useful fishes," by which act

the people, for this purpose, surrendered to private parties, being riparian owners, all their fishing rights in every pond of less area than twenty acres, also in every unnavigable stream in the State. It also made fishes artificially cultivated or maintained the absolute property of the person cultivating or maintaining them. It also made it a penalty of $20 to $50 to fish in any waters in the State in which fishes are lawfully artificially cultivated or maintained.

The commissioners called the attention of the people to this law in their report for the year ending January 1, 1870, in the following words: "The need of such a law as this is the same as the need of a law to protect any industry. While on the one hand we recognize the fact that a supply of good fresh-water fishes, among which we class the salmon, shad, trout, black bass and smelt, are essential as food for our people, we are still compelled to admit that the supply is constantly diminishing, and that several of these fishes are in many localities exterminated. For this deplorable state of things there was but one remedy, and that was to make fishes under certain conditions property, and thus give the same stimulus to the cultivation of fish that is given to the raising of any other live stock. Under the knowledge we now have such cultivation is as easy as that of poultry."

The successful cultivation of trout is no longer a matter of doubt. It has passed through the experimental stages and now stands out as destined to become one of the great industries of the people, and it will if the several States will only realize the importance of encouraging the industry by repealing or modifying the restrictive laws in relation to the sale of artificially reared trout. Some of the States have already done this. Connecticut, Rhode Island and Maryland have modified their laws in relation to the sale of trout artificially raised, and a bill to that effect has already passed the Massachusetts Senate, and is now pending in the House of Representa-

tives, and we trust New York and other States will follow suit in the near future. Our trout are all artificially reared from the egg, in artificially made ponds and on artificial food which we buy, and we pay a tax not only on our plant but also on our trout as stock in trade, and the law declares them to be our absolute property.

Under these conditions we feel that we are entitled to the same property rights in trout at all seasons of the year that every class of property that is useful to man as a food product has, namely, the right to sell it at any and at all times when it is desirable to do so, and that our customers and ourselves shall be the judge of when that time is and not the State. Remove the restrictions from the sale of cultivated trout from January 15 to April 1, and people now in the business will enlarge their establishments to their utmost extent to meet the largely increased demand, and others will be induced to enter into the industry to such an extent that ten years hence fifty pounds will be raised annually where one is now, thus giving employment and wealth to the people engaged in the industry, taxation to the towns and State, and the advantage of having this additional amount of food fishes added to the food product of the country during the latter part of the winter, when nearly every kind of fish is scarce and often in poor condition, while cultivated trout are in fine order. It is an old adage that he who makes two blades of grass grow where one grew before is a public benefactor, and it must be admitted that he who makes ten thousand to twenty thousand pounds of trout grow annually where none grew before is also a public benefactor, and if restrictions against the sale are removed or modified, large tracts of now waste land and water will become valuable for the cultivation of trout, and the expectations of Dr. Garlick, Dr. Ackley, Ainsworth, Seth Green, Livingston Stone, Theodore Lyman and other early disciples of fishculture will be realized, much valuable property created annually, many persons bene-

fitted, and no one in the least injured. I trust this society will give this subject careful consideration, and that the laws of the several States will soon be changed so as to give full justice to fishculturists.

STATE CONTROL OF STATE FISHERIES.

By Hoyt Post of Michigan.

At the last meeting of this society, just at the close of the session, there was hastily adopted a resolution, prefaced by four whereases, upon a subject matter which has since attracted considerable attention in certain quarters.

This resolution related to petitioning Congress to assume the work of protection and propagation of fish in the waters of the great lakes, and the whereases suggested taking this work out of the hands of the several States which are now conducting it, it is said, "with slight probability of ever arriving at a harmony of action," and placing it in the control of the Federal Government, which, it is stated, could, "with its great scientific, mechanical and financial resources, its power to make agreements with Canada, and its ability to enact and enforce regulations," "undertake this work with far greater results" than have heretofore been attained. This resolution was a source of surprise to several of the State Commissions, and especially to that of Michigan, which took prompt action upon it.

In October, 1891, a meeting of the Fish Commissioners of New York, Pennsylvania and Ontario, with representatives of the United States Commission, and some others especially interested in the subject, was held at Fifth Avenue Hotel in the City of New York, the object of which was stated to be the "protection, pre-

servation and propagation of food fish in the great lakes."

This meeting appointed a special committee which met at the Chamber of Commerce in Rochester, New York, on November 10th, 1891, at which meeting a series of resolutions was adopted, which were afterwards reported to the final meeting at Hamilton, Ontario, December 8th, 1891, and there finally adopted. The portion of the resolutions which pertain to the matter under consideration in this article is as follows, viz.:

"*Resolved*, That this body regards with disfavor any movement looking towards the turning over to the United States Government the work of the State Commissions in propagating and planting commercial fish in the great lakes;

"That the jurisdiction over the State Fisheries belongs naturally to the adjoining States, whose interest in their success is paramount to that of the United States as a whole; and

"That there is an abundant field for the concurrent action of the bordering States and of the General Government, and anything which would detract from the State's interest in this matter will be detrimental to the end aimed at, of restocking the waters of the great lakes;

"And we recommend a course which will encourage and stimulate greater interest and larger expenditures in this great work by the several bordering States, and at the same time increased interest in the subject by the United States Fish Commission;

"*Resolved*, Further, that this body earnestly approves of the action of Congress in making an appropriation for the establishment of a hatching station on or near the St. Lawrence River for the propagation of white fish and other commercial fish; and of the purpose of the United States Fish Commissioner to carry out the provisions of that appropriation; and we see nothing in this movement

that can in any degree interfere with the jurisdiction of the States in the premises, or to affect in any way unfavorably the work of the States in the protection, multiplication and distribution of valuable food fishes."

Afterwards the same subject was again brought prominently into view by the introduction in Congress at its present session of the Lapham Bill, so called (H. R. 5030), entitled "A Bill to regulate the Fisheries and for other purposes." This bill related on its face to the taking of menhaden and mackerel with purse scines along the sea coasts and shores of the United States and adjacent islands and in the bays, harbors and estuaries thereof, but it contained an insinuating reference to the great lakes. Its evident aim was to extend the jurisdiction of the Federal Government over fisheries in waters which are within the exclusive jurisdiction of the States. This bill received such energetic opposition from the States of Maine and Massachusetts, aided by the Board of Fish Commissioners of Michigan and other States, that the Committee on Merchant Marine and Fisheries, to whom it had been referred, decided by a vote of seven to six that it was unconstitutional.

Thereupon the promoters of said bill caused a new bill to be introduced which was known as H. R. 7553 and which was identical in principle with the former one. This bill was afterwards unanimously decided to be unconstitutional.

The plan of interesting Congress and the Federal Government in the matter of Federal control of the protection of the commercial fisheries, has attracted considerable attention at various times for several years. From a superficial survey of the subject it seems to those not thoroughly informed, very desirable because of its tendency towards uniform rules and laws governing all the fisheries. Consequently the matter has been often considered, and while at first blush it appears very promising yet the conclusion uniformly reached after careful

inquiry is that it is impracticable because Congress has no jurisdiction under the Constitution over the fisheries in waters which are within the boundaries of the States. A thoughtful consideration of the whole subject, however, convinces most persons that it is also undesirable as well as unconstitutional.

October 17th and 18th, 1883, an interstate convention of fish commissioners was held at Detroit, and at the request of the Michigan Board, Otto Kirchner, who was then Attorney General of the State, examined the authorities and announced to the convention his conclusion that it was not within the powers of the Federal Government to assume control of the fisheries in waters within the State boundaries.

Within the present month John Z. Rogers publishes over his own signature in *Harper's Weekly* of May 14th, 1892, an article in which he forcibly depicts the rapid decrease in the catch of codfish, mackerel and lobsters within the past ten years, and shows that the depletion caused by the destructive methods of fishing has resulted in the ruination of the business, and concludes, as so many others have, that the remedy lies with Congress passing laws for the protection of the fisheries.

In view of the precedents upon the subject and the repeated decisions of the courts that Congress has no authority over the matter, it is surprising that people of intelligence should so persistently fall into this error. The right of the State over the fisheries in waters within its borders has been the subject of frequent decisions of the courts of this country, and those decisions have been uniform and without conflict or variation in favor of the exclusive jurisdiction of the State authorities. These decisions are not confined to the State tribunals, but the most potent and forcible of them were enunciated by the Supreme Court of the United States. This unbroken line of decisions commences as early as 1823, with the case of *Corfield* v. *Coryell*, 4 Wash. C. C., 371, and

comes down to the recent case of *Manchester* v. *Massachusetts*, 139 U. S., 258, and embraces elaborate and exhaustive opinions of such eminent jurists as Washington, Story, Marshall, Curtis, Waite, Bradley and Shaw.

The right of the State to control its own fisheries is sustained by the courts as a property right, and as an incident to the ownership of the soil beneath the waters, which has never been ceded or delegated to the United States, and it is held that the State may exclude citizens of other States from using said fisheries and may regulate their use at its direction.

It has been sought again and again to uphold the right of Federal supervision of the fisheries in navigable waters under the grant of power to regulate commerce; but this has been uniformly and repeatedly overruled by the courts. The possession of a United States "fishing license" has been set up as a defense for the violation of State regulations; but it has never been sustained. Legislation by Congress has been urged on the ground that citizens of each State should have equal rights with the citizens of the State in which the waters were, of fishing for floating fish in any navigable waters, but the power of Congress over the matter has been uniformly questioned and ultimately denied. Such a bill was introduced at the first session of the Forty-ninth Congress, and was numbered H. R. 4690. It was referred to the Committee on Judiciary and was reported adversely. The report was drawn by that able constitutional lawyer, J. Randolph Tucker of Virginia. The conclusion of that report is, "that the navigable waters within each State belong to it, subject to the paramount right of navigation, for the benefit of its own people, and it has the right to secure the exclusive right of fishing in them to its own citizens by virtue of their common property in said waters, and that the citizens of other States have no constitutional right, nor can Congress confer any, to participate in fishing in them." This right of the State

is treated as a property right and not a mere privilege or benefit of citizenship.

It is worse than useless then to look to Congress or to invoke the authority of the Federal Government, to protect or control or to interfere in any way with the regulation of the fisheries within the States. It has no power, no authority, over them, and cannot possibly acquire any short of an amendment to the Constitution, which could never be obtained. It is a State matter, and the State alone must be looked to for its proper administration. The sooner this becomes generally known and recognized the sooner will people cease chasing this *ignis fatuus* and direct their undivided attention to the proper authorities to correct the evils complained of, and by placing the duty and responsibility where it naturally and of right belongs, will more surely accomplish the desired results.

Federal control of the commercial fisheries is not only unconstitutional and therefore impossible, and incapable of enforcement; but it is eminently undesirable and unnecessary.

To properly frame the laws necessary for the regulation of fisheries and the protection of the fish from indiscriminate and exhaustive slaughter, requires intimate local knowledge of the innumerable differences of temperature, climate, fish food and habits, of varying spawning periods and the feeding and spawning grounds, as well as the various and constantly changing methods and devices of the law breaker. These laws must have the moral support of local public opinion; they must be wisely drawn and promptly and discreetly enforced; they must admit of proper discrimination to avoid hardship; and any mistakes or defects be capable of prompt remedy, to adapt the penalties to the varying circumstances. Defects in the fisheries laws to adapt them to the widely varying surroundings of particular localities will be more suitably remedied by a speedy appeal to the

State Legislature, than by recourse to a distant and overburdened Congress. The speedy and continuous vindication of the law against the repeated assaults by reckless and unprincipled fishermen, who are spurred on by the hope of great present profits, can far better be entrusted to numerous and easily accessible local tribunals than to distant and leisurely Federal courts. While uniformity of rules and regulations, which seems to many the highest and almost the sole desideratum, undoubtedly has its merits, it is manifest that a discriminating and readily adapted legislation, vigorously enforced by local officers, prompt to respond to public interests, will be more effective than general ironclad regulations made by a National Fish Commission and enforced by United States officials, practically irresponsible to local sentiment. Practical experience has demonstrated that anything in the nature of police regulation is, in the long run, better left to the control of local authorities, administered by local officers before local tribunals. Local self-government has long been recognized as the strongest bulwark of popular sovereignty and the surest guarantee of our free institutions.

In strange contrast to the persistent advocacy here of Federal control and supervision of the fisheries, is the course of our neighbors over the border. In Canada a determined effort is now being made to have the control of the local fisheries taken out of the hands of the Dominion and given over to the Provinces.

In conclusion we commend the sentiment expressed and the course recommended in the resolutions adopted at the Hamilton meeting, quoted above, and which were formulated by the Michigan Commission and spread upon its records soon after the adjournment of the last meeting of this Society, as a refutation on the part of the members of that commission of the action of this society in passing the resolution mentioned at the beginning of this article.

After the above was read, the following remarks were made:

MR. DOYLE—I think the question should be brought up. We have been fighting the menhaden men as to the purse nets. We would like to get, as Judge Potter suggests, an expression of opinion in regard to the attempt of the menhaden people to take away from the State authorities the control of the State Fisheries.

MR. BEAN—Before the Fisheries Society takes any action on this resolution of Judge Potter, I should like to say one thing of the United States Fish Commission. I do not say it officially. I have no right to speak for the commissioner, but I know, and I think it must be very well known to the gentlemen of the Fisheries Society, that this is not a bill which originated with the UnitedStates Fish Commission; the United States Fish Commission have no desire to control State fisheries, and I think it is perfectly clear to our members that it is merely an effort on the part of the menhaden interests, or some other private fish interests, and we should not be misled by it.

MR. DOYLE—I had no desire to reflect upon the United States Fish Commission.

MR. BEAN—They are not connected with it in any way and disclaim any responsibility for it.

MR. DOYLE—We know the United States Fish Commission are not pushing the bill.

THE PAST AND FUTURE OF FISH-CULTURE.

An Historical Glance at the Cultivation of the Waters.

Under the above title Mr. C. Raveret-Wattel has sent an interesting paper to be read before the society to-day of which I give below an abstract. The paper was originally read at the conference of the National Acclimatation Society, February 27th, 1891.

The review of the history of fishculture given by the author while necessarily brief is very complete. Touching lightly upon the efforts of the ancients to preserve their fisheries, he comes down to modern times and tells us how in the year 1840, during an exceptionally dry year, Joseph Remy, a Vosge fisherman, studied the habits of trout and took from them spawn and milt in a jar filled with water. The eggs proved fertile. This discovery having been made, Antoine Gehin contributed money to aid Remy in prosecuting his researches. Before this, in 1758, one Jacobi, an officer of the Principality of Lippi-Detmold, had fertilized the eggs of trout and salmon and had published his discovery in 1763, but it appears to have attracted no attention.

These discoveries might have been entirely forgotten if it had not been that in 1848 a French naturalist, led by his scientific studies to consider the subject of the increase of fish, presented to the Academy of Sciences a work upon this question. M. de Quatrefages, whose learning and clear judgment enabled him to recognize the importance which the cultivation of the waters would one day take on, did not hesitate to state that it was possible to sow fish as grain is sown, and from this time he proposed to sow the sea. He pointed out the method by which the product of ponds could be regulated; by which the eggs of fish could be used for the restocking

of streams; called attention to the opportunities which these methods offered for the acclimatation and dissemination of species, and in a word traced out at that time a programme of fishcultural industry. As may be imagined, this memoir by M. de Quatrefages created the greatest interest. It was followed by the enthusiastic labors of M. Coste. The fishcultural establishment at Huningue was founded in 1852.

The author discusses the difficulty which the early fishculturalists were obliged to overcome, and touches especially on the importance of fishways. Facts and statistics with regard to fishculture in France, England, United States and Sweden are given, as well as estimates of the money value of fishculture in certain streams, especially as to the cultivation of the shad in American waters running into the Atlantic. He describes the fish-cars used in the United States and gives many other details familiar to most of us. The author closes by urging that France, which initiated the science of fishculture, should not stand still and allow herself to be outstripped by other nations.

FISHWAYS.

By W. H. Rogers.

Among the many causes for the decrease of fish in the rivers, as well as along the coasts of this and other countries, the impassable milldam unquestionably occupies first place. A river, as to its production of fish. may be compared to a fruit tree, the larger the tree and the more numerous the branches (other things being equal), the greater the quantity of fruit it will produce; but to girdle it anywhere on its lower part, will effectually destroy its producing capabilities. An impassable dam thrown across the lower portion of a river, has precisely the same effect. as to the production of fish, and most effectually

destroys not only anadromous fish, but almost all valuable river fish as well—for in their search for food, and to propagate their species, almost all river fish are more or less migratory at certain seasons of the year. In proof of this, all sorts of fish inhabiting the Hudson River are seen passing up the fishway recently constructed on the Mechanicville dam, and I have seen them pass up many other fishways, both in Canada and in this country.

The dam, moreover, by preventing the fish from ascending the river, causes them to accumulate below the obstruction, where they fall an easy prey to the industrious poacher of every description.

At this same point also, are found mill refuse, sawdust or poisonous drugs thrown off by the mills and factories, which, from being in bad company, bear much of the odium fairly belonging to the more deadly dam.

Sawdust and other wooden substances may be dismissed as being comparatively harmless, while the poisonous drugs and dyes are usually confined to one side of the river, the fish avoiding them by passing up along the opposite shore, while on rapid-running streams intersected with dams or falls, the water reoxygenates itself at a short distance below the point of contamination. So that, unquestionably, the dam and the poacher are the greatest hindrance to the improvement so much needed and sought after.

Much has been and may be done in restocking depleted waters by the artificial propagation of fish, but where dams exist little improvement has been effected, especially in anadromous fishes, as they descend to the sea, but cannot return to their native rivers, or to the upper portion of them. Therefore, to open the dams with proper fishways, is to add greatly to the value of pisciculture, as well as to directly increase the quantity of fish.

Shad and river herring usually spawn in the still

waters; therefore, the artificial ponds produced by the construction of dams will have the effect of improving the rivers, as to the production of these fish, once the dams are provided with good, passable fishways; and to overcome natural falls, is to allow all anadromous fishes to reach long stretches of inland waters, heretofore inaccessible—a matter of vast importance.

Such considerations as these add immensely to the importance and value of fishways, especially when it is remembered that the improvement of the river fisheries, which send out to the bays and harbors their annual supply of young fish, brings the coast and sea-fish near the shores, and into the estuaries and bays, where they can be more readily caught.

Did the people generally more fully understand the facts in relation to this matter, and its inevitable effect upon food as well as game fish supply, I doubt if in five years there would be a dam or fall in this country, unprovided with a proper fishway.

Facts and statistics are at hand to clearly prove all I say here, but time forbids their reproduction. I may say, however, in a general way, that all the rivers in Canada that have been provided with good fishways for a number of years, are filling up with fish at a rapid rate—so much so that in many places the people living in the neighborhoods are surprised.

A proper device to fully reconcile water power and the fisheries, has been long and industriously sought by parties and countries interested, but chiefly by those who have had little experience or practical knowledge of the nature of the many difficulties to be overcome. Many inducements have been held out with a view to calling out the inventive genius of mankind, and the accumulation of plans and models at the London International Fisheries Exposition, were numbered by scores; but two only of which received any notice at the hands of the judges whose duty it was to pass upon their merits.

A fishway, to be successful, must be one that can be applied to all forms of dams and natural falls, one that will provide a slow, natural stream at all heights of water, with the entrance for the fish close to the obstruction and placed where they will readily find it, and one which will not injure the water power on the smallest stream. But after such a device has been produced, much experience in the location and construction is necessary, or failure is almost sure to follow; because almost all dams and falls have difficulties to be overcome, entirely their own, which must be met by the proper application of the fishway to the obstruction. To employ an inexperienced man to do this work, is to invite failure in a great majority of cases. Large sums of money have been lost by the adoption of such mistaken methods to master difficulties which only an expert can accomplish, and such is the nature of the obstacles to be overcome, that even a man of experience may sometimes make fatal mistakes.

So far as a decision of the merits of any form of fishways is concerned, the proofs must be supplied by the fish themselves, in the rivers at the dams, for gold medals and other prizes given at expositions and world's fairs are liable to be awarded upon theoretical devices which too often fail when put to actual test.

In this as in most other cases, an ounce of fact is worth more than a pound of theory.

The Rogers' Fishway, which is now in successful operation on many dams and falls in Canada as well as in this country, fully and completely meets all the foregoing conditions and requirements. Its width, five feet; depth, two to three feet; form of internal construction and resultant, slow and unbroken stream, are each and all indispensible in a successful fishery; in these respects it is different from any other in use on either side of the Atlantic and can be constructed at moderate cost so as to successfully pass any sort of

river fish over dams or falls of any height and to effectually resist ice, drift logs, trees or stumps, etc. It cannot be carried away by freshets, unless the dam itself first gives way. It is also constructed so as not to interfere with the permanency of the dam or efficiency of the water power and only in rare cases is it necessary to cut the obstruction or to remove a stone in it.

This fishway is not a mere invention, thought out by a theorist who had but a vague idea of the numerous obstacles to be mastered, but is rather a growth, a detailed mastery of all the difficulties met with down in the rivers amongst the fish and the dams. It is the outcome of a quarter of a century's personal experience, close observation and anxious effort. It leaves nothing to be desired in a successful fishway, which it is possible to produce, therefore there is no need in longer spending money in fruitless experiments on theoretical and useless devices as in the past, but address ourselves to the more practical work of passing the fish up the stream as fast as possible.

After the paper was read Mr. Gilbert said: Within the last twenty or twenty-five years there have been a great many fish-ways invented and devices to get fish up the rivers. I have no doubt many of them have been successful. The State of Massachusetts put in a fish-way at Holyoke. We have also had very expensive fish-ways constructed at Lawrence, Manchester and all the falls. Yet the results, as given by the Massachusetts Fish Commission in their last report in relation to shad, which says, "Returns show a catch of only 12,451 shad taken inland waters, a decrease from last year of over 2,000," are not encouraging. Why is this? If we have these fish-ways, on which the State has expended large sums of money to build and maintain, and yet we have the mortifying result that the shad are decreasing, why is it?

The fact is that while the State has expended thousands of dollars to get the fish up, they have never expended one cent to get them down. They have overlooked that. On streams which are not given to manufacture it is very easy to get up and go down over the falls. But on rivers like the Merrimac and the Connecticut, used for manufacturing purposes, how are those fish to get down, especially during the season when these young shad go to saltwater, which is along in July and August, when the waters of the Merrimac and Connecticut are low. It is true a little water may run in the fish-way; but it is the habit of all these fish in descending and ascending a river to go where the strongest current is through the wheels. The fish of the Connecticut and the Merrimac, ninety-five per cent of them I venture to say, go through the wheels. And what are those wheels? They are a tub and wheel. And a fish an inch and a half long can no more go through that wheel than he can go through a meat chopper. Nothing can go through. What are you going to do about it? There is only one thing, and that is to stop the manufacturing or else take out the wheels. Years ago, when the Mill act was passed, overshot wheels were universally in use. Now, a fish can go through an overshot wheel without any danger. It is a very important consideration how you are going to get fish down. At the Russell mill, where I have been employed for a number of years, rather than to put a fish-way in, they carry the fish up, cart them up and put them into the river above. There are millions hatched there but there is not one goes down through alive.

Mr. Rogers—My experience of a quarter of a century in this matter is that young fish have no difficulty in finding their way down. Herrings and shad go down is September in that country; during that month, all of that month. There is abundance of water going over the tops of the dams, and fish can go down wherever water goes. I have investigated the wheel idea, and I have known

young fish to go through by thousands, and go through alive; through the (tribune) wheel, which is a wheel that receives its power from specific gravity, and the fish goes through as a part of the water without being hurt at all, unless they happen to strike and get a little stunned, but they come to life when they get below. This is my experience. I bow to any facts the gentleman knows, of course, but I assure you there is no difficulty in a young fish going down any river in this country,

Mr. Ford—I think the greatest works are those that have been recently accomplished jointly by the New York and Pennsylvania Fish Commissions in the fish dam at Lackawaxen over the Delaware River. They are the Rogers Fish-ways and by them we have been enabled to allow the shad to ascend the Delaware River. They are most efficacious. They have sent the shad up nearly a hundred miles above the Lackawaxen dam, and that they come down again, I can say from personal observation. Not only the large shad come down the fish-ways, but during the summer time, in August, September and October when the young shad comes down, the river almost glitters with the shad leaping from the water. There is no trouble about shad coming down the fish-way. They have had that much more spawning ground added, nearly a hundred miles more of water. They have gone up the fish-ways in such numbers, that in the next stage up above in New York State, in the report made by the New York Commission in 1891, this is spoken of as a solid mass of fish waiting under the dam to get up, and the report calls upon the New York Fish Commission to put fish-ways up there to let them go further.

Dr. Hudson asks the height of the dam.

Mr. Ford—I think about eight feet. The fish-ways work to a charm. We have lots of them in the dam across the Susquehanna River, a very long dam, and shad have been going in considerable numbers forty to fifty

miles above that dam. It is the purpose of the commission to add fish-way after fish-way until we can finally send the fish up again to New York State line, where formerly they were caught in larger quantities than they are caught in the Delaware to-day.

MR. ROGERS—At Mechanicville Dam, a stone structure sixteen feet high, fish were jumping there, salmon, trying to get over. I saw six in one pool close to the dam; Two of them would weigh thirty pounds. Those salmon, as soon as the fishway was done, went right up. My son went through the fish-way from bottom to top and found fish in every apartment. Last year a large number of salmon were caught away up at Baker's Falls, fifty miles above the dam.

I also put one in the Northumberland dam, thirty miles above, and they went through that.

MR. CARY—Do you know positively that shad ever pass up through? It is well known that salmon will go everywhere that shad will.

MR. ROGERS—If they can send shad over the Troy Dam, they could over the Mechanicville Dam. I have put shad over a dam in Canada seventeen feet high.

MR. CARY—Is it positively known that they did pass up!

MR. ROGERS—Yes.

MR. POWELL—About the young shad being destroyed going to the sea. It has been a good deal of discouragement to our commission. We have four hundred miles of fish water, useless for commercial purposes, full of islands. We try to propagate and protect those fish. We have been trying for years to get the State of Maryland to join with us to pass laws uniform to our State. We are making a great effort to keep those fish there from passing out. They have twelve miles and we have four hundred. It is very discouraging for us to raise those fish and let those people catch them in twelve miles.

In regards to these fish-ways, I have a letter in my

hand which I wrote to a party to know whether they had any fish caught at their station (Newport). This letter states that there have been only seven caught on account of the flood, all small male shad about two and a half pounds apiece. Mr. Rogers I presume will explain that from the fact that the females follow the male.

Mr. Rogers—They got them in a dip net. Shad keep out in the current and these dip nets are on the shore; that would account for the small quantity caught. The male fish both in salmon and shad, go ahead of the females; the females come up later.

THE SUSQUEHANNA.

ITS PAST, PRESENT AND FUTURE.

By A. F. Clapp.

The Pennsylvania Canal Company commenced building dams as feeders to its system about the year 1826. Previous to that time the Susquehanna River had been one of the most prolific for at least three species of anadromous fishes, the shad, the herring and the striped bass or rock fish, as good fishes of commercial value as any of the Atlantic coast series, and besides these there was an abundance of non-migratory species which furnished ample food for the dwellers along and in the vicinity of its shores. From the time of the erecting of these obstructions commenced the gradual decline of all species and the total loss to all dwellers above of all the migratory tribes except the eel, which found its way through rifts and crevices. Soon other factors of destruction became operative, notably soils washed in from cultivated lands, and later, the immense quantities of debris from the anthracite coal fields which now covers the bed of the river in all pools and eddies, to the almost total destruction of the natural spawning grounds and

life of the eggs, from the Lackawanna coal fields at Scranton on the North Branch to the bay at Havre de Grace. The time is also not far distant when the same condition will obtain in the West Branch, from the bituminous field of clearfield and above, unless a halt is called, and all this deleterious matter is made some other disposition of. As far as relates to soil wash, it seems unavoidable, but proper legislation and enforcement of the laws could remedy the other. The sulphur impregnated water from the mines acts only locally and is gradually desseminated and purified, but to the abatement of the dumping of mine refuse into the streams tributary to the main river must we look if the waters are ever to be again rehabilitated. The dragging of seines over the spawning beds, catching the gavid fish from off their nests and covering up the spawn already deposited has been another fruitful source of depletion. There are laws to deal with this feature, and the fault lies in the proper enforcement. Up until the early seventies when artificial propagation and restocking was introduced, the supply of all classes of food fish had gradually diminished until the waters was almost barren. Striped bass, shad and herring had disappeared with the erection of the dams, while the pike perch, locally termed the Susquehanna salmon, the pickerel (*Es. ret.*) the yellow perch, the sunfish and catfish, the most esteemed of the non-migratory fishes, had almost entirely disappeared. With the organization of our fisheries commission, about 1870, began a practical regeneration. The black bass, as a new variety, has proved wonderfully prolific, and several others of the smaller perch family have obtained a fast hold. These waters seem best adapted to the precoids, and greater efforts in stocking with this species ought to be persisted in. The reintroduction of wall-eyed pike or pike perch has been manifesting itself in increased numbers very perceptibly. When fish propagation assumed important proportions,

we had hoped much for this river as a fit habitat for the Pacific salmon, and many hundred thousands of fry were placed in the upper Sinnemahoning and other tributaries only to remain a year or two as smolts and parr and then disappear. Only one adult specimen did I ever see or hear of, and that came ashore here dead, killed probably in some log jam above during the June freshet of 1889. This specimen would, I estimated, weigh about thirty pounds and was in prime condition, too much putrefied to remove from the water, but was an undoubted quinnat salmon. I gave an account of it at the time to FORREST AND STREAM and to T. H. Bean at Washington, but saw afterward that he was probably in Alaska, as I got no acknowledgment of my letter. Trout (*Sal. Font.*) were common in the early years of the present century, but as the settlements increased, the forests became depleted, the water roiled and temperature increased, they decamped for cooler and purer springs.

I have been familiar with this river for forty years and have followed its changed conditions with much interest and with increasing alarm unless the public can be roused up to effective effort for its preservation. The future of our noble river, with its broad expanse, looks gloomy indeed, and not only the Susquehanna, but is it not true of most of our American rivers? And what can we hope for but depletion unless intelligent public sentiment can be aroused to arrest the destructive influences. Our Fisheries Society is doing its best and exerting a healthy influence, and it is with the view and hope of discussion, and efforts that may eventually lead to more important results, that I respectfully submit this paper for your consideration.

SUNBURY, PA., May 16.

The following discussion took place:

MR. POWELL—We have been asking for the last three or four months to get an opinion as to coal countries, and the people who are running this water into the streams, and whether it would be advisable for us to make a test case against one or more of these companies. But up to this time I cannot get any official opinion. I was invited by this society to prepare a paper on the subject, but could not get the data together to do so as quickly as I would like to. It has got to be one of the most important questions. It appears in certain counties north of us here that there has been a waste of coal dust, possibly for years—fifty years. Somebody devises a patent to wash this coal dust out, pass water through it, and selling it for fifty or sixty cents per ton right on the ground. We get all the water and they get all this cheap coal. It goes further than that: I can name a dam near Harrisburg where sand diggers are digging fine coal out of the bottom of the river. It not only keeps the water back, but it is destroying all the food that the large fish live on. Possibly for two or three or four hundred yards from shore, the bottom of this river is covered with this coal dust. It is going to be an important question; I have had a number of letters from other States in regard to it.

AMERICAN SALMON AND OTHER FOOD FISHES.

By Prof. Bushrod W. James, A.M., M.D., Philadelphia, Pa.

While all who are interested in the great question of the protection of the seals in Bering Sea are waiting anxiously to hear of the final arbitration decision, we may turn a while to the study of the interest whose promise seems to be great in regard to both money making and the more plentiful and less costly supply of a very desirable food, the Salmon.

Western salmon eggs have been carried in safety to the rivers on the eastern coast, and no doubt they will soon yield abundantly; the shad fisheries in the Delaware have been saved from dissolution by artificial hatching, the return having been raised from 60,000 to 500,000 within a very few years.

German carp and English brown trout take very kindly to our smaller streams and sluiced ponds; there is no doubt that they would become plentiful if they were properly protected; but from the very small boy with his string and crooked pin to the more nobly equipped man of leisure, all seem to think that each alone has the privelege to take fish from whatever quarter in which he sees they are abundant, and it is just possible that a depleted private pond is the victim of some such marauder instead of having been visited by kingfishers, water snakes, or other disastrous visitants. The number of enemies from whom fish suffer has always been so great that nothing but their extreme productiveness could have saved them from total extinction long ago. And when we think of the popularity of weir and seine fishing, it is wonderful that there are any of the more desirable kinds remaining! even in the Karluk River, on Kadiak Island, Alaska, the most productive salmon fishing ground in in the United States, there is a perceptible decrease in the number of fish caught in late years, which is ac-

counted for by the use of the large seines, which not only make immense hauls of fish useful for canning, but they catch the breeding fish which they prevent from ascending the minor streams for the purpose of spawning; thus not only destroying the fish that is not good for food, but preventing the propagation of the species. Other valuable fish are caught with the salmon and ruthlessly cast aside to die on the beach, where they lie decomposing by thousands. In Pennsylvania the laws have prohibited weir fishing, and the increasing numbers of fish in our streams show the wisdom of the commission in obtaining such protection. If the United States Commissioner could secure such lawful safeguard for the salmon of Alaska, it would insure an almost interminable future for the vast industry in the territory, whose canneries would one day be able to supply the world.

The planting of fish fry is an undertaking which requires wisdom in the selection of the waters for the purpose, and a careful regard to the habits of the finny occupants. A voracious variety of fish for instance, will sometimes clear all other species from the pond or stream in which they are placed; black bass has this reputation, therefore the folly of trying to raise trout with the rapacious varieties in the same stream is apparent.

Perhaps there is no industry that makes more ample return than that of catching and preparing fish for the markets. In Alaska the canneries yield an immense profit, and they deal in salmon alone, the yield of halibut, cod, and other kinds of fish is not included in the vast industry; but Alaska herring and smelts are said to be particularly fine and no doubt they will soon attract capitalists to set up a strong rivalry with other parts of the world in their production for the markets.

The supplies of cod, mackerel and herring from the eastern coast has so long been an institution, that remarks concerning them seem superfluous; perhaps too, no one can fully appreciate the great importance of these

fisheries to the inhabitants of the eastern coast, from Labrador to Nantucket, unless it were possible to cut off entirely for a time, the yields of fish from the bay of Fundy to Long Island Sound, we could not estimate how many of the citizens are dependent upon the products of the sea. As it is, the alarming diminution of the catches of mackerel, cod and lobster in those eastern states has gone far towards ruining some of the minor towns along the coast.

The greed of speculators, who saw how well the fishermen were able to support themselves and their families with their primitive modes of obtaining their stock for trade, and who introduced purse-seines, drag nets, trawls, and weirs, thereby catching enormous quantities of fishes in all stages of their existence, and with blind fool hardiness glutting the markets—have bestowed upon the born fishers a trial, from which the older members of the community can never recover, by draining the bays and coves of the larger and more valuable of all kinds of fishes. Those which their devices did not catch have been so frightened that they have left the runs; and unless the United States laws interfere with decisive and immediate exercise of their power, and forbid the use of those modes of fishing; both old and young inhabitants will forsake the coast, take up with some other industry in order to gain a living; or, worse still, they will leave their native land and go to the Canadian shores, from which even now there are great quantities of fish imported into this country.

But let us hope that no such disaster may befall our honest fishermen and our eastern states; instead, we must strive by every measure to increase the numbers and varieties of the beautiful food fishes, and to have laws enforced for their permanent protection.

Perhaps because there is a greater proportion of water than land on the face of the earth, there is no more universal article of food than fish in existence. Among the

most refined epicures, or on the tables of the poorest classes in nearly every country, fishes of various kinds take an important part. The daintily prepared salmon or trout, followed by other luxuries in one household, is represented by mackerel or herring in another, with perhaps no other addition to its savoriness than its rival staple, bread. In fact there are few people of any grade who are not fond of some one of the silvery denizens of the water; and from humanity down to the smallest warm blooded animal, from the greatest mammal of the sea to the smaller fishes; even reptiles are fond of fish and all wage a constant war upon their numbers; and how many, both human and animal, derive their whole sustenance from this one source alone.

There was once a prevalent idea that fish had a peculiarly nutritive effect upon the brain; science does not substantiate that notion, but undoubtedly in a piscatorial diet there must be considerable health and strength. One attribute of such nutriment seems to be tenacity of life. Among the Esquimos, for instance, there are tribes who live exclusively on fish, seal meat and oil, and a few berries; they have no salt. The fish is broiled when fresh, eaten raw when dried, and some even consider putrid fish heads a most delicious dainty; they live in underground huts with no ventilation of which to speak; they fairly reek of fish, and yet some of them live to quite a good age. This goes to prove that there is a vast amount of nutrition in the food, and that the careful propagation of the best food fishes of the world is a noble and necessary employment.

Among all the finny tribes, salmon and cod of the larger fishes, trout and mackerel of the smaller, seem to be most important. from the salmon fisheries of the north-west alone there is derived an enormous profit; Columbia River salmon has long been classed as the finest in the world, but Alaska is steadily advancing until it has already come into favor equal in many ways with the

Columbia. Some writers say they are the same fish, others claim distinction, but they are both very fine, and that the canneries have acquired a prominent industry in the territory, none will dispute.

Of Alaska salmon there are five prominent varieties, each with special points of favor among the natives.

The KING SALMON is the finest of all in flavor but its color is not so beautifully tempting as that of some other varieties. Its average weight is twentv pounds, though some have been known to attain a weight of seventy-five or eighty pounds. The king salmon is claimed to be the identical Columbia River salmon, whose repute is world wide, and which grow to an enormous size. I have seen specimens along the Columbia River at the canneries, which weighed about eighty pounds and looked as large as an ordinary sized man.

In Alaska, salmon fishing and packing has not attained very great commercial importance as yet, because this fish runs most numerously in the Yokon River, and its tributaries, which are so distant from the markets as to make the expense too great for the undertaking, No doubt an early day there will be canneries established and good modes of transfer furnished to ambitious merchants; and when the Columbia fails to give such vast supplies, the Yokon will provide for all deficiencies in that quarter.

During the running season the natives are wild with delight; they feast upon the fresh fish, but do not store it as they do some of the families, perhaps because it cannot be caught in the great quantities that they are able to obtain of the other kinds. The greatest drawback to the king salmon for importance in the markets is that it is difficult to catch them in large numbers on account of the rough waters in which they run.

The DOG SALMON is a favorite with the natives, who make feasts, dance and make gifts to the river Gods who permit them to come in such quantities for their delec-

tation. These and the hump-back variety are the kinds most used for drying and preserving for winter use, as well as for barter with the northern traders. The dog salmon is found in nearly every river in Alaska, even very far north, and its extreme abundance is one trait for which it is favored by the Alaskans, though it is much smaller than some other kinds.

The SILVER SALMON is not so important as those before mentioned, though they are used for canning in some places. They arrive late in the season, which may account in a great measure for their being less popular The supply is generally laid in, and the hungry natives have sated themselves before their tardy arrival; therefore they are not so eagerly sought. This is one of the nest building fishes, whose curious habits have been the study of scientists. They actually wear their snouts away in pushing the stone in place for their nests.

The HUMP-BACK SALMON is the smallest of the Alaskan salmon, and the most abundant. These are the fishes of which it has been said they are more numerous than the drops of water in which they live! The natives catch them with sticks filled with nails, which they plunge into the schools, and by which they get enormous returns by simply scraping them up and flinging them ashore to the women who are in waiting, and to whom the duty is entrusted to disembowl them and prepare them for drying. The wildest excitement greets their coming, and the people simply gorge themselves with the fat products of their fishing. This fish is another that is yearly abundant and widespread over the territory, but it has comparatively no commercial value, because of its being remarkable for its rapid decomposition on exposure to the air.

The RED SALMON is the one now holding the most merchantable importance of all the salmon tribe; and in this case, as in many others, beauty has supplanted merit, for the flesh is really not so palatable as that of the king

or the silver salmon, but its rich red color has become so desirable that other kinds are filling subordinate places for the present, at least.

These poor little fishes have many difficulties to surmount: They run in very turbulent waters, they are sought after by man and beast, they have been threatened with extermination by the excessive greed of those who would like to take the season's catch in one great haul. And yet they are very abundant so far. Just here comes the opportunity for the question of the protection of the fish—not only of the salmon of the great North-west, but of the beautiful food fishes of our own immediate streams and rivers as well.

I note a successful exchange of edible fish with Great Britain, with apparent favorable results. Now, if foreign fish will thrive in interchange, I think there should be wider diffusion of the varieties in the waters of the United States.

Alaska is not limited to salmon alone, though it is most useful of all; there are trout, greyling, white fish, and many other small fishes; and the black cod, the sturgeon, and the famous halibut; all grow to perfection in the pure, snow-fed waters of the territory.

The value of the salmon alone is wonderful, and it may be increased with no apparent limit for years. In 1889 there were thirty-six canneries in operation, representing an outlay of four millions of dollars. A vast sum, but the product of the year was estimated at three millions of dollars. Certainly a good interest for the money expended.

While we are speaking of the enormous products and profits of the West, we must not forget the steady, plodding industry of the East, where for years the sturdy fishers have gained an honest living. They smile at the wild stories of the North-western fisheries as if they thought it was but a flash in the business that will soon settle to a quiet, rather uncertain status such as their

own; and so it will, in shorter time than it required for the coast of Maine to attain its present quietude, if the wholesale slaughter of all sorts and conditions of the defenceless creatures is not discontinued.

Fishculture, and the protection of the breeding fish and of the young fry are becoming more decidedly urgent each year; but the Government has taken the matter under its own protection, and now we need no longer fear the extinction of some of the favorite finny races.

I think there is no sport more truly widespread than that of the fisherman. It passes through all grades of society, from the dainty lady who wants to fish but screams at the sight of the necessary worm, to the sturdy aleut who only rejoices in it from its positive necessity for the sustenance of his family; yet one could envy him the myriads of pretty, silvery creatures waiting for his barbed stick, while our Eastern rivers hold such chary beauties that no coaxing with dainty morsels can win them to the hook. And yet the fascination returns periodically. The fisherman takes his basket, his hook and line, or flies—as the case may require—he starts off hopefully, his appetite already sharpened with the bright promise of the day's sport; and if he returns with nothing but a very hungry stomach, very delapidated clothing, and a weight of weariness upon him, he will forget it all and be ready for the next season of trout or salmon! North, South, East and West, it is the same. And as if in indulgence to the love of the sport, there is nothing so prolific as fish. Produced by the million every year, they are surely sent for some great good.

From the coarse grained cod of the north-east, to the delicious salmon of the north-west; from the bulky halibut to the slender speckled trout; from the northern mackerel to the highly flavored shad; all have their votaries; all take their places among the most valuable living productions of the world; why then should they not be carried from one part of the Union to another?

Why should they not be protected from destruction? Artificial hatching has so far been successful so that there need be no limit to the production of graceful fishes that may swarm our streams and reward the patient fisherman for his hours of anxious waiting and his days of disappointment.

And now a few words concerning the diseases of salmon: Apart from all other enemies to which salmon are subjected, even in the pure waters of Alaska, nearly all are infested with a parasite, of which collections were made by M. McDonald, United States Fish Commissioner, who was appointed to visit and investigate the fisheries of Alaska; his report states that they were not able to classify the species, therefore it cannot be determined whether they are hurtful to the fish or not. Probably in artificial hatching the fish may be freed from the parasite, and then by comparison it can be found whether they are detrimental to the quality of the flesh or not.

The Encyclopaedia Britannica notes a peculiar fungoid growth in the salmon of the rivers in Great Britain which has destroyed many of the fish since its discovery in 1877. I find no notice of a similar disease having been found among the salmon of this country, but it would be well if all who are interested in pisciculture would watch and report the first appearance of any fungus growth among their stock.

The disease takes the form of ulcerations, which eat away the skin, producing inflammation and sloughing, bleeding sores. By examination it is proved that the fungus is the cause, and not the result of any other disease.

The fungus bears such close resemblance to the saprolegnie ferax which is found upon dead house-flies and other decaying animal or vegetable matter, that it has been mentioned as identical with it; but it is not fully proven; neither is there proof that it propagates so quickly among the salmon as to become epidemic.

There seems to be a wide field for investigation in regard to this fungus, and it would be advisable for all who are engaged in the business to watch closely and give opportunities for a thorough study, if any disease of the kind threatens the fish under his supervision or observation.

The following discussion took place:

MR. CARY—I would like to ask one question in regard to the paper: If I heard correctly you allude to German carp as being a predacious or destructive fish to other fishes?

MR. JAMES—Where they cannot get their own food. It is so stated in the report I read some time ago, that the German carp would live on its own kind of food—which is vegetable food—but rather than die, it will consume its own kind.

MR. CARY—In connection with this, there was an article published in Ohio, alluding to this fact, speaking very much against German carp as being predacious fish. I have had a good deal of experience with the German carp in the State of Georgia. We have no evidence that they are to any extent. If a large number of carp were confined in a small space, I suppose they would eat one another sooner than perish; but I don't think unless I have sure positive proof of it, that German carp is predacious.

MR. JAMES—Where they cannot find sufficient vegetable food. They are a rapidly growing fish and require a great deal of food to make them grow in that way; and that is the statement that I got from an article which led me to introduce it in the paper. They are not usually a voracious fish as such.

MR. MATHER—I think the ichthyological portion of that paper on the Alaskan salmon is exceedingly good. I am glad as an ichthyologist that the subject came up. Dr. Bean published something on it I believe.

A NATIONAL SALMON PARK.

By Livingston Stone.

Who would have thought thirty years ago that the creation of a National Park in this country would be the means of rescuing the buffalo from extinction? Who thought then that anything was needed to rescue the buffalo? The buffalo roamed in myriads over the plains and mountain slopes of the central portions of the United States and were so innumerable that, with the exception of a few far-sighted persons, no one thought that this noble race of animals was even in danger. The supply seemed inexhaustible and the species at least safe from extinction.

How soon we found out our mistake, and how suddenly the change came. The note of alarm had hardly been sounded long enough to be distinctly comprehended over the country, before the buffalo was gone—all gone practically, except a few straggling survivors which, if they had not found refuge in Yellowstone Park, would have been gone too, long before this. The Yellowstone National Park saved them. It saved the wild race from extinction, and if nothing else should ever be accomplished by the creation of the Park, this alone would, in the writer's estimation, justify its existence.

But if anyone had said thirty years ago, "Let us form a National Park in the buffalo region for a protection and refuge for the buffalo," the proposition would have been laughed down from one end of the country to the other. It would have been thought a most ridiculous expedient, a scheme too foolish and crazy to be even seriously entertained. Nevertheless, the creation of the National Park has accomplished this very object, and has been, I think it may be safely said, the only means of accomplishing this most important object, the preservation of the American buffalo.

Now what this paper is going to propose will appear,

doubtless, just as ridiculous, just as foolish and crazy, as the formation of a park for the preservation of the buffalo would have been thought thirty years ago. It is nothing less than the creation of a national park for the preservation of our salmon.

I hear already from all directions the question, "What do the salmon need a park for? Are there not plenty of places of safety for them already in all the rivers and streams of this country, not to mention the pathless ocean where man cannot follow them?"

It looks so at first sight, I admit; but let us try to find these places of safety if they exist, and then see how it looks. We certainly cannot find them on the Atlantic coast, where the scanty yield of the only two American salmon rivers—the Kennebec and Penobscot—is only a drop in the bucket compared with the total consumption of salmon. Passing over to the Pacific coast we find only the Sacramento, the Columbia and the lesser streams on the Washington and Oregon coast, and in all these the salmon are about as safe as the fur seals were last year in Behring Sea.

I will say from my personal knowledge that not only is every contrivance employed that human ingenuity can devise to destroy the salmon of our West coast rivers, but more surely destructive, more fatal than all is the slow but inexorable march of those destroying agencies of human progress, before which the salmon must surely disappear as did the buffalo of the plains and the Indian of California. The helpless salmon's life is gripped between these two forces—the murderous greed of the fishermen and the white man's advancing civilization—and what hope is there for the salmon in the end? Protective laws and artificial breeding are able to hold the first in check, but nothing can stop the last.

To substantiate this statement, which may seem exaggerated, let me inquire what it was that destroyed the salmon of the Hudson, the Connecticut, the Merrimac

and the various smaller rivers of New England, where they used to be exceedingly abundant? It was not overfishing that did it. If the excessive fishing had been all there was to contend with, a few simple laws would have been sufficient to preserve some remnants, at least, of the race. It was not the fishing, it was the growth of the country, as it is commonly called, the increase of the population, necessarily bringing with it the development of the various industries by which communities live and become prosperous. It was the mills, the dams, the steamboats, the manufacturers injurious to the water, and similar causes, which, first making the streams more and more uninhabitable for the salmon, finally exterminated them altogether. In short, it was the growth of the country and not the fishing which really set a bound to the habitations of the salmon on the Atlantic coast.

Let me illustrate this same statement more in detail by presenting the testimony of the salmon rivers of the Pacific coast. Take for an example the Sacramento. When the first rush of Gold seekers came to California in 1849, every tributary to the Sacramento was a fruitful spawning ground for salmon and into every tributary countless shoals of salmon hastened every summer to deposit their eggs. When the writer went to California in 1872, only twenty-three years later, not one single tributary of the Sacramento of any account was a spawning ground for the salmon except the McCloud and Pit rivers in the extreme northern part of the State, where the hostility of the Indians had kept white men out. It was not fishing by any means that had caused the disappearance of the salmon, for the miners did very little fishing in those times; but it was the debris from the quartz mines which drove the salmon out, ruining the spawning grounds and rendering the river uninhabitable for the salmon.

This was in 1872. In 1878 the writer took 14,000,000 of salmon eggs from the summer run at the U. S. Sal-

mon Station on the McCloud river. In 1883 the Southern Pacific Railroad Co. (then the Central Pacific) extended their line northward up the Little Sacramento, crossing the mouth of Pit river, into which the McCloud empties a mile or two above.

So disastrous to the salmon was the effect of the road building along the Little Sacramento and the mouth of the Pit, that that year it was with great difficulty and only by very hard work that we succeeded in getting barely 1,000,000 salmon eggs, and the next year Prof. Baird, in disgust at what he considered the unpardonable indifference of the Californians, discontinued taking salmon eggs at this station. Since that time sawmills of immense capacity have been erected at the head of the Little Sacramento and the McCloud, and have done very effective work in increasing the now alarming scarcity of the spawning salmon of the Sacramento.

I think these instances are sufficient to show that what the friends of the salmon have to fear more than overfishing, is the growth or development of the country always attendant upon an increasing population, but the fatal consequences of which to the salmon it is impossible to avoid. Nothing can stop the growth and development of the country, which are fatal to the salmon. For instance, there was no power in the world that could have prevented the mining on the Feather, the Yuba, the American Fork or the other spawning streams of the salmon; nothing could have stopped the building of the railroad up the Little Sacramento or the erection of the Sawmills on the upper McCloud. They came along naturally and inevitably in the march of events, and they could not be withstood; and nothing was left for the salmon but to suffer the consequence and disappear as by a decree of fate.

Now actual fishing in the salmon streams can be regulated by law and rendered comparatively harmless, but the country will continue to grow more and more populous and

the fatal march of civilization will proceed as irresistibly as ever. That cannot be held back, and unsafe as the salmon are now in our Atlantic and Pacific coasts rivers, they will become more and more unsafe every year; all of which goes to show that there is no safe place for the salmon within the limits of the United States proper.

This leaves us only Alaska. Now, how is it with the salmon streams of Alaska? Not even there are the salmon safe. Countless myriads of salmon formerly filled all the rivers and streams of the long Alaskan coast, and they were nearly 2,000 miles from the destroying hand of civilized man, but they were not safe even on those distant shores. The ubiquitous canneryman found them, and he already has his grip on the best and most fruitful of the Alaskan rivers. The pressure of the world's demand on the world's supply of canned salmon renders it necessary for the salmon canner to occupy more distant and less fruitful fields every year, and it is only a question of time when all the Alaskan salmon streams are given over to the canneries, and when that time comes no one will claim, I think, that the salmon are safe in Alaska.

One or two illustrations are sufficient. The Karluk River on Kodiak Island is probably the most wonderful salmon river in the world. On Aug. 2, 1889, the cannery nets caught on Karluk beach at the mouth of the river, 153,000 salmon by actual count. A short time after, the writer went up the Karluk River in a bidarka—the skin boat of the natives—expecting to see myriads of salmon spawning and thousands on their journey to the spawning grounds, but instead of the wonderful sight we anticipated, our whole party, I think, saw less than a dozen in the river till we reached the lower spawning grounds, and then to our astonishment we saw only a few scattering fish spawning, such as one might expect to see in the most commonplace salmon river in the world; 153.000 salmon caught in one day at the mouth of the river, and none to speak of going up the river to reproduce their

species. Every one can draw his own inference, The fact is significant enough.

On another river, a large one, the Nushagak, where vast numbers of salmon were taken at the mouth one summer for canning, we were told that the succeeding winter the natives living up the river were brought to the verge of starvation because the salmon which they had always depended on for their winter's food were so scarce. Of the thousands and thousands of salmon that usually ascend the river to spawn, not enough spawners escaped the nets at the mouth to keep the natives on the upper waters from starving. This fact speaks for itself also.

So much for the safety of salmon in Alaska in general, but it would yet seem that on the uninhabitable shores of the Arctic Ocean the salmon might find a place of refuge, but not even there can they stay unmolested, for parties were planning three years ago, the writer was told, to establish canneries on the affluents of the frigid and forbidding Arctic. So we see that our salmon are not safe even in Alaska, their last refuge, and if not there, they are not safe anywhere within the limits of our broad land.

But now the question comes up, "Will not protective laws and artificial breeding make the salmon secure enough?" My answer is that good laws and artificial breeding will do a good deal toward it, but not enough. Good laws can prevent overfishing, but no laws can arrest the encroachments on the salmon rivers of increasing populations and their consequent fatal results to the salmon. No laws could possibly have been enacted which for instance would have stopped the manufacturing enterprises on the Connecticut, or the vast water traffic of the great metropolis at the mouth of the Hudson which doubtless drove the salmon out of these rivers. Protective laws may regulate the salmon fishing of the Sacramento, but no laws can stop the mining, the

logging and the railroad building that are destroying the spawning grounds of the tributaries of the Sacramento. It is not in the power of law enactments to save the salmon from all their dangers.

Artificial breeding can do a great deal, and has done a great deal, but it cannot be relied upon for a certainty. In the first place it is very uncertain where one can find a suitable place for hatching salmon. The writer traveled over four thousand miles up and down the Columbia and its tributaries, from the Continental divide to the Pacific coast looking for a good place for salmon hatching, first in 1877 for the Oregon and Washington cannerymen, and afterwards in 1883 for the U. S. Fish Commission, and found only two places in that great stretch of country which were suitable, one on the Clackamas River where the writer built a hatching station, and the other on the Little Spokane a few miles from Spokane Falls, which is still unoccupied.

There is in all the great State of California but one stream suitable for salmon hatching on a large scale, and on this stream, strange as it seems, there is but one spot that meets all the requirements of the case, and that is the place that the writer selected and built upon, on the McCloud River in 1872, and named Baird, in honor of the distinguished Commissioner, under whose direction the work was done.

Allow me to add by way of conformation that subsequently the State Fish Commission of California, after hunting all over the State for another place for hatching salmon, have given it up and now get their supply of salmon eggs from the Government station at Baird.

The above instances illustrate the difficulty of finding suitable places for hatching salmon on a large scale, and not only is it not easy to find such places, but they cannot be relied upon to a certainty when they are found, for they are always in danger from logging, mining, railroad building, lumber manufacturing and other

causes which yearly become more imminent and dangerous as the country gets settled up and the population increases, and which threaten at any time to destroy their efficiency.

We must come to the conclusion then that even with the help and support of protective laws and artificial breeding, our salmon, like the buffalo of thirty years ago, are not safe. The destroying agencies of advancing civilization drove the buffalo to the last ditch, so to speak, and then the last survivors, or almost the last, were slain. They were obliged from sheer necessity to come to feed. where from all directions the hand of man was raised against them. Whether they turned to the north or to the south, to the east or to the west, they went to their certain death, and in an incredibly short space of time they practically disappeared.

The story of our salmon is analogous. They are obliged to come inland to breed. They are compelled from sheer necessity to come up the rivers into the very midst of their human enemies. They cannot stay in the ocean like other fishes of the sea, where they are safe from the hand of man, but they must necessarily come, one might say, into his very grasp, and, like the buffalo, whether they turn to the north, south, east or west, they go into the very jaws of death ; for what hope is there for a salmon to escape after he has entered a river, if man chooses to employ his most effective agencies for his capture? There is none. The salmon is doomed. There is no alter of refuge for the salmon in this country any more than there was for the buffalo.

Ought not something be done, then? Ought this state of things to continue? The salmon of the United States are one of our most valuable posessions. As a matter of ordinary prudence, ought not the country to have some place, if it is possible, where the salmon can come and go in safety? If a stock raiser saw that his cattle were daily diminishing because they had no spot where they were

safe from beasts of prey, what kind of a man would we think he was if he did not very soon fix a place where they would be safe.

We should. to draw it mildly, think he was very improvident and negligent. Is it any less improvident and negligent for this country not to provide a place for its rapidly diminishing salmon where they will be safe? It seems to the writer that not a day ought to be lost, but that if it is possible to provide a place where our salmon can resort unharmed and remain safely their allotted time, it should be given them without hesitation. If there is such an asylum of refuge within our borders, by all means secure it for the salmon and let the salmon have it for an eternal heritage.

Is there such a place within the limits and jurisdiction of the United States? The writer can say from personal knowledge that there is one place at least. Most fortunately for us Americans there is in our Alaskan possessions just such a place as is wanted—probably more than one—and so exceptionately fortunate is America in this respect that it is not likely that this side of the frozen and uninhabited shores of the Arctic, it can be duplicated many times in the possessions of all the nations of the earth combined, which significant circumstance, allow me to add in passing, goes to show how near the world has reached the extreme limit of its salmon supply.

The locality which the writer has in mind is an Island in the North Pacific about 750 miles nearly due west of Sitka. Its name is Afognak, and it is the northernmost of the two largest islands of the group, called the Kadiak Islands. It lies just north of latitude 58° and between 152° and 153° west longitude. It is a small island. probably not over fifty miles across at its widest part, but there are several streams flowing from various points of the island to the surrounding ocean. and at the proper season contain salmon innumerable. It is no exaggeration to say that salmon swarm up these streams in countless

myriads. When the writer was on the island in 1889, the salmon was so thick in the streams that it was absolutely necessary in fording them to kick the salmon out of the way to avoid stumbling over them. I know that this story is an old salmon chestnut, but it illustrates as well as anything the wonderful abundance of salmon in the Afognak streams; and it can be easily believed when it is remembered that about a month earlier 153,000 salmon were caught in one day at the mouth of the Karluk, which is a river only 60ft. wide where it empties into the ocean. But there is no need of consuming time in proving the abundance of salmon at Afognak Island. It is a matter of record. The salmon are there in as great numbers as could be wished. All the varieties which also inhabit the Pacific Ocean come to Afognak. The list is as follows; it is a royal catalogue:

1. The red salmon, the "blue back" of the Columbia (*Oncorhynchus nerka*).
2. The king salmon, the "quinnat" or "spring salmon" of the Columbia (*Oncorhynchus chouica*).
3. The silver salmon, the "silversides" of the Columbia (*Oncorhynchus kisutch*).
4. The humpback salmon (*Oncorhynchus gorbuscha*).
5. The dog salmon (*Oncorhynchus keta*).
6. The steelhead, the "square tailed trout" of the tributaries of the Columbia (*Salmo gairdneri*, *Salmo truncatus*).
7. The Dolly Varden (*Salvelinus malma*).

It is easy to see what a paradise for salmon this island is, and what a magnificent place of safety it would be if it were set aside for a national park where the salmon could always hereafter be unmolested. But the abundance and variety of its salmon are not the only recommendations that Afognak Island has for a national park. It has several others which may be enumerated as follows:

1. The island is inhabitable all the year round, with a

comparatively even temperature. Although so far north. the winter's cold is not excessive, probably not equalling that of parts of New England. It is cooler than New England in the summer, it is true, but there is much less variation of temperature between summer and winter.

2. The rivers of Afognak still exist in all their original purity and fruitfulness. No overfishing has left them barren. No mills have polluted their primeval purity. No railroads have frightened the salmon away from them. No mining has disturbed their native spawning grounds. As salmon rivers they are still in their original glory. To quote a not inappropriate line of Byron, "Such as Creation's dawn beheld" them, they are rolling now. Consequently nothing need be done nor any expense incurred in putting the rivers in order for asylums of refuge for the salmon.

3. No complications now exist or can come up in future, in regard to land titles in this island. The United States Government owns the land already like the rest of Alaska, by direct purchase from Russia, and has never parted with any of its exclusive rights of ownership. No State or Territory, or company or individual owns an acre of it. Consequently the U. S. Government can set aside the island for any purpose whatever, without interfering with any prior rights or titles, or incurring any risk of litigation.* Alaska is already one great reservation.

4. The island will probably never be wanted for any thing else. The summer season is so short that no crops can be raised there, and it is not likely that for many generations, if ever, the land will be wanted by permanent settlers, and it is now inhabited only by a few Aleuts and half breed families who would not be interfered with. There would be no injustice done to individuals by making a reservation of the island.

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* There are two canneries operating in the southern part of the island, but there would probably not be great difficulty in making satisfactory arrangements with them.

5. Last but not least, artificial hatching can be instituted there at any time, if it is ever thought best, and on a vast scale if desired; and unlimited numbers of the eggs of the various kinds of salmon noted above, can be obtained for distribution and sent to all other parts of the country where they may be needed.

The above considerations seem to indicate that Afognak Island possesses all the qualification required for a place of safety for our Pacific Ocean salmon without presenting any objections to its being reserved by the Federal Government for salmon, or in other words, converted into a National Salmon Park.

The writer, however, would not urge the claims of Afognak or any other place to this distinction as against those of any locality that may be found to be better fitted for it. This island has been brought forward merely as showing that one place at least is known that would answer the purposes of a salmon park. There are doubtless others in our Alaskan possessions. There are possibly better ones. If a better place can be found, let us take it. If not, let us take Afognak Island; but at all events let some place be selected and set aside by the authority of the National Government. If not Afognak Island, let it be some other place. Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impracticable, or at least very difficult. Now is the time. Delays are dangerous. Some unforeseen difficulties may come up which we do not dream of now, any more than we did a few years ago of logging on the Clackamas, or railroad building on the upper Sacramento.

If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon are gone they cannot be reclaimed. Exaggerated as the statement seems, it is nevertheless true that all the power of the United States cannot restore the salmon to the rivers after the work of

destruction has been completed. The familiar nursery rhyme about the egg applies here with peculiar fitness:

"Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses and all the king's men
Could not set Humpty as before."

That is the whole thing, so to speak, in an eggshell. After the salmon rivers are ruined all the king's horses and all the king's men, that is to say, all the power of the government, "cannot set them as before."

Let us act then at once and try to do something for the salmon before it is too late. Dangerous complications may come suddenly upon us which we cannot foresee. How little we foresaw the danger to the buffalo and the fur seals. How suddenly the disastrous results came. Even if not impracticable it may cost large sums of money to do hereafter what may be done now for nothing. No expense may be incurred at present. All that is required is to have Afognak Island or some other suitable place set aside by national authority as Gen. Grant set aside the McCloud River Reservation during his administration, and it can be left to further events to decide whether it is expedient to expend any money on the reservation, a subject that can be safely left, we all know, in the hands of our efficient Commissioner of Fish and Fisheries. There seems to be no impropriety in the United States having a national salmon park, but on the contrary it appears eminently proper that a great natural salmon country like ours should have set apart some safe repository and fruitful breeding grounds for this noble fish.

Consider for a moment what the salmon has done for us, and then think how mercilessly we have treated him. Our salmon has been to us a source of national revenue, enjoyment and pride, and what return have we meted out to him? He has been hunted pitilessly with hooks and spears, with all kinds of nets and pounds, with wheels and guns and dynamite, and there is not a cubic foot of

water in the whole country where he can rest in safety. The moment he comes in from the ocean he meets the gill nets and the pounds at the mouth of the river, the sweep seines further up, and hook everywhere, and at last on his breeding grounds, which at least ought to be sacred to him, he encounters the pitchforks of the white man and the spears of the Indian.

Let us now at the eleventh hour, take pity on our long-persecuted salmon and do him the poor and tardy justice of giving him, in our broad land that he has done so much for, one place where he can come and go unmolested and where he can rest in safety.

Allow me to add in closing that it seems to me highly appropriate that this society, which represents with such intelligence and ability all the fishing interests of every kind in this country, should take the initiative in a matter in which those interests are so closely concerned. The writer trusts that it will, and ventures to predict that, if its efforts in that direction should happily be rewarded by the creation of a national salmon park, it would become an enduring monument to the usefulness of the Society that would last as long as the Nation lasts.

EARLY HISTORY OF THE FISHERIES ON THE GREAT LAKES.

By Herschel Whitaker.

Stretching away to the northward from the low Laurentian hills of New York to the trap-rock cliffs of Minnesota, for a distance of sixteen hundred miles, in a hydrographic basin embracing an area of one hundred and seventy-five thousand square miles, lie the Great Lakes of the Northwest, the largest bodies of fresh water upon the globe. Upon their bosoms float vast fleets which carry the rich products of prairie, forest and mine, while from their depths the fisherman gathers the rich bounties that nature has provided for the sustenance of man.

The vessels which constantly pass and repass are not freighted with ores from the mines of Golconda nor with spices from Far Cathay, but carry lumber from Saginaw, iron from Escanaba, copper from Hancock, grain from Duluth, provisions from Chicago, and cereals from the vast prairie lands of the Dakotas.

Since the early days of the French occupation of the Northwest, when the lilies of France waved over all the territory lying north of the St. Lawrence and Ohio and west of the Alleghanies, these lakes have been the great highway of intercommunication between the East and West. The Jesuit missionary filled with holy zeal departed from Montreal, the seat of French power in America, in his bark canoe, manned by his Indian converts, for the trackless wilds of the far West to raise the cross and establish his feeble mission among savage tribes.

Following him came the fur trader with his canoe and *courrier du bois*, who day after day traversed these lakes and their connecting rivers to reach some specially designated place where he might exchange his tawdry

gewgaws, beads and cheap merchandise with the Indian for the valuable skins of beaver and otter.

The cavalier, explorer and adventurer traveled over their trackless wastes of water, enduring hardship and fatigue, living upon the bounties of nature, pushing his way to what he hoped would be a discovery of a path to the Indies, fortune and fame. Each of these in his own way has left testimony of the bountiful way in which nature has stocked these waters with desirable food, and the belief of all concurred that there was an unfailing supply for man for all time, to be had for the taking.

The habits of the tribes bordering these lakes whose main reliance for food was upon the fishes that inhabited them, had caused them to resort to certain favorable localities upon the lakes at the proper season of the year to take fish for present wants and for future use. In time these points became their chief dwelling places for the greater portion of the year, and with the advent of the fur trader they became the principal places of barter.

Such localities as the Straits of Mackinaw, Sault Ste. Marie, Green Bay, Chequamegon, Detroit and Chicago became thus early known, and the history of these places as told by the early traveler shows that nature seemed to have lavished her bounties upon aboriginal man in the stocking of her waters with the most edible of fishes to provide for his wants.

Let us call a few of the earlier voyagers to give their testimony upon the abundance of fish in these waters.

Hennepin says in his Travels in 1675: "There is a very abundant fishery of several kinds of fish at the mouth of the Niagara River, among which is the whitefish, admirably good, with which you might supply one of the best cities of Europe.

"At Mackinaw the Griffin lay in the harbor amid one hundred and twenty canoes going and coming from

taking the whitefish, which the Indians catch in nets in from fifteen to twenty fathoms of water, and without which they could not subsist at all.

"At the Sault the Indians subsist by hunting stags, moose or elk and some beaver, and by the whitefish which is very good and is found in great abundance, but this fish is very difficult to take to all but these Indians, who are trained to it from childhood."

He says, on his return from his first voyage up the lakes, and after the loss of the Griffin: "On reaching Lake Conti (Lake Erie) near the mouth of the Detroit River, the soldiers who were in canoes killed with their swords and with their axes more than thirty sturgeons which came to spawn on the banks of the lake."

Charlevoix, in his voyage to North America, 1721, in speaking of Lake St. Clair, the smallest lake of the chain which lies between Lake Erie and Lake Huron: "The islands in the river seemed placed on purpose for the pleasure of the prospect, and the river and the lake abound in fish. Were it not for the Hurons at Detroit the other tribes of Indians would starve. This is in the flat lands thereabout which would furnish them sufficient subsistence though it were cultivated ever so little, but they can subsist upon the fish of the river which are plentiful. We entered the Lake Huron where we soon had the pleasure of fishing for sturgeon."

Speaking of Lake Superior, he said: "The Indians from gratitude for the plentiful fish with which this lake supplies them, and from the respect which its vast extent inspires, have made a sort of divinity of it." Speaking of Michillimackinas, he says: "The Indians live entirely by fishing, and there is perhaps no place in the world where they are in greater plenty. The most common sort of fish in the three lakes which discharge themselves into these straights are the herring, the carp, the goldfish, the pike, the sturgeon, the attikumaig or whitefish, and especially the trout. There are three sorts of these

taken, among which is one of monstrous size, and in so great quantities that the Indian with his spear will strike to the number of fifty sometimes in the space of three hours, but the most famous of all is the whitefish, and nothing of the fish kind can exceed it."

In speaking of his trip from Mackinaw to Green Bay, he says: "We coasted the north shore of the Straits of Mackinaw and finally came to the Manistique River, which is a beautiful stream abounding in fish, especially the sturgeon."

Captain John Carver, of the Provincial troops of America, in his three years' travels throughout the interior parts of North America, says: "Lake Superior abounds with a variety of fish. The principal and best are the trout and sturgeon, which may be caught at all times in the season in the greatest abundance. The trout in general weigh about twelve pounds, but some are caught that exceed fifty. Besides this a species of whitefish is taken in great quantities here that resemble a shad in their shape, but they are rather thicker and less bony. They are about four pounds each in weight and are of a delicious taste. The best way of catching this fish is with a net, but the trout might be taken at all times with the hook. There are likewise many sorts of smaller fish in great plenty here, and which may be taken with ease. Among these is a sort resembling the herring that are generally made use of as a bait for the trout."

Speaking of the falls of Ste. Marie, he says: "Nature has formed a most commodious station for catching the fish which are to be found here in immense quantities. Persons standing on the rocks that are adjacent to it may take with dipping nets about the months of September and October, the whitefish before mentioned at that season, together with several other species. They crowd up to this spot in such amazing shoals that enough may be taken to supply, when properly cured, those inhabitants

throughout the year. The fish of Lake Huron are much the same as those in Lake Superior."

Carver arrived at Mackinaw at the beginning of November, 1767, after having been to the Mississippi River and up that stream as far as the Falls of St. Anthony. He says: "We passed the winter very pleasantly at the Straits of Mackinaw. One of their amusements at this time was to fish through the ice for trout. Though the Straits were covered with ice we found means to make holes through it, and letting down a strong line fifteen yards in length to which we fixed three or four hooks baited with the small fish before described, we frequently caught two at a time of forty pounds weight each, but the common size is from ten to twenty pounds. The method of preserving them during the three months the winter generally lasts, is by hanging them up in the air, and in one night they will be frozen so hard that they will keep as well as though they were cured by salt."

This may properly be considered as the first authentic notice of preserving fish by the freezing process, and while it is crude it still was as effective as the work now done by the immense freezers found in almost every important town on the lakes.

George Heriot, Deputy Postmaster General of British North America, in his book of travels, published in 1807, says of Mackinaw that the Indians of that locality "catch herring, whitefish and trout, the trout being from four to five feet in length, some of which are seventy pounds in weight. This fish is bred in Lake Michigan and is known by the name of Mackinaw trout, and affords a most delicious food." Of Green Bay he says: "There is a village composed of natives at the mouth of this river who employ themselves in fishing."

At the Sault Ste. Marie, "At the bottom of the rapids and among their billows which foam with ceaseless impetuosity, innumerable quantities of excellent fish may be taken from the spring until winter. The species

which is found in great abundance is denominated by the savages attikumaig or whitefish. The Mackinaw trout and pickerel are likewise caught here. These afford a principal means of subsistence to a number of the native tribes."

He also speaks of the method of taking the whitefish at this place in the rapids at the foot of the falls, which, singularly enough, is followed by the Indians to this day, and from its peculiarity deserves special mention. I give his own words:

"No small degree of address as well as strength is employed by these savages in catching these fish. They stand in an erect attitude in a birch canoe, and even amid the billows they push with force to the bottom of the waters a long pole, at the end of which is fixed a hoop with a net in the form of a bag, into which the fish is constrained to enter. They watch it with the eye when it glides among the rocks, quickly ensnaring it and dragging it into the canoe. In conducting this fishing much practice is required, as an inexperienced person may, by the efforts which he is obliged to make, overset the canoe and inevitably perish. The convenience of having fish in such abundance attracts to this situation during the summer several neighboring tribes, who are all of an erratic disposition and too indolent for the toils of husbandry. They therefore support themselves by the chase in winter and by fishing in the summer.

"The Otter Nation inhabit the rocky caverns on Lake Huron, where they are sheltered by a labyrinth of islands and capes. They subsist on Indian corn and fish and the proceeds of the chase. While the women and children collect berries the men are occupied in darting sturgeon."

Mr. Henry R. Schoolcraft from the time of the establishment of the military post at Sault Ste. Marie, was the United States Indian Agent at this point. He was a man of culture and literary ability, and one of the most pro-

lific contributors to the literature concerning the habits, characteristics and language of the North American Indians. He says of the whitefishing at the Sault in 1820:

"No place in America has been so justly celebrated as a locality for taking this really fine and delicate fish as St. Marie's Falls. This fish resorts here in great numbers, and is in season after the autumnal equinox, and continued so until the ice begins to run. It is worthy the attention of ichthyologists. It is a remarkable but not singular fact in its natural history, that it is perpetually found in the attitude of ascending at these falls. It is taken only in the swift water at the foot of the last leap or descent. Into this swift water the Indians push their canoes. It requires great skill and dexterity for this. The fishing canoe is of small size and is steered by the man in the stern. The fisherman takes his stand in the bow, sometimes bestriding the vessel, having a scap net in his hand. This net is made of strong twine, open at the top like an entomologist's. When the canoe has been run into the uppermost rapids and a school of fish is seen below or alongside, he dextrously puts down his net and having swooped upon a number of fish, instantly reverses it in the water, whips it up and discharges its contents into the conoe. This he repeats until the canoe is loaded, when he shoots out of the tail of the rapids and makes for the shore. The fish will average three pounds, but individuals are sometimes taken two or three times that weight. It is a great resource of the Indians and of the French, and of the poor generally at these falls who eat it with never-ceasing appetite. It is also a standing dish with all."

Listen to his tribute to the edible character of the whitefish:

All friends to good living by tureen or dish,
Concur in exalting this prince of a fish,
So fine in a platter, so tempting a fry,
So rich in a gridiron, so sweet in a pie,
That even before it the salmon must fail,
And that luscious *bonne bouche* of the land beaver's tail.

* * * * *

'Tis a morsel alike for the gourmand or faster,
While white as a tablet of pure alabaster,
Its beauty or flavor no person can doubt
When seen in the water or tasted without,
And all the dispute that opinion ere makes,
Of this king of lake fishes, this "deer of the lakes,"
Regard not its choiceness to ponder or sup,
But the best mode of dressing and serving it up.

Sheldon, Disturnell, Strickland, Kohl, Hubbard and others all unite in saying that nature here seems to have lavished her bounties with no niggardly hand, so profusely are these lakes stocked with fish.

From the time of the discovery of the lakes down to the time of the establishment of the Hudson Bay Fur Company, these inexhaustible supplies were drawn upon only for the subsistence of the Indian tribes and the voyagers, but gradually they became, to a small extent, an article of commerce, the surplus being salted and sold in somewhat inconsiderate quantities. During all this time the northwestern territory was looked upon as a source from which valuable furs could be obtained, and but little attention was paid to the fisheries of the Great Lakes beyond what the immediate wants of those who lived upon them or near them demanded.

Little is known at the early time of which I speak with reference to the fisheries of Lake Erie, because of its situation it was but little frequented by the early explorers and fur-traders. Good reason existed for this condition of affairs. The blood-thirsty and cruel Iroquois, the most adventurous and warlike Indian tribe which ever inhabited the continent, held undisputed possession of all that wilderness lying about Lakes Ontario and Erie and adjacent to the NiagaraRiver, which was a key of approach to the latter lake.

The rivalry between the Dutch fur-traders of New York and those of the French was exceedingly intense in their attempts to control the fur trade of the Northwest. The Iroquois were incited by the Dutch to throw every obstacle possible in the way of encroaching advances by the French traders and colonists. For many years the Iroquois, who by reason of their situation acted as intermediaries between the further western tribes of Indians, controlling in their own interests the fur trade between the Dutch and these tribes, fiercely resented all attempts at interference in this trade by the French. As a result of their attitude the great waterway communication between Montreal, the seat of the French fur trade, and the Great Northwestern lakes was closed by the Iroquois, and communication with the upper lakes was made by way of the Ottawa and the French Rivers into Georgian Bay and from thence into lakes Huron, Michigan and Superior.

Meagre, however, as the information is that we have concerning the condition of the fisheries on Lake Erie at this early period, such information as we have shows beyond question that fish were exceedingly plentiful, especially at the Put-in-Bay Islands and Sandusky Bay. Dr. McCallum of Dunville, Ontario, at a meeting of the International Fish Conference, held at Hamilton last winter, exhibited to the meeting two crude shellfish hooks which were found on Point au Pelee, in the Province of Ontario on the North Shore of Lake Erie. These hooks were presumably made from the shell of the freshwater mussel. In appearance they resemble the rude hooks employed for taking fish by the Esquimaux and other aboriginal types. The shank and the point were in two separate pieces, having holes drilled through them by which they could be attached to each other with thongs, the hook itself being barbless. Their form and construction indicated plainly that if the aboriginal man was compelled to sustain life by means of fish taken

with such an implement, the fish must have been exceedingly plentiful in this lake. Facts at hand would seem to indicate that Lake Erie was in these early days bountifully stocked with fish, and although it has been fished constantly for a very long period, it still yields immense quantities of valuable commercial fish.

Blois, speaking of the condition of the fisheries as early as 1835, in his "Gazeteer of Michigan," says: "Their quantities are surprising, and apparently so inexhaustible as to warrant the belief that were a population of millions to inhabit the lake shores they would furnish ample supplies of this article of food without any sensible diminution."

Looking at the matter from that period of time the writer was unquestionably warranted in his assumption. But Blois could not have apprehended at that time that the census of 1890 would show that in the six States surrounding the Great Lakes there was a population constituting more than one-sixth of the entire population of the country. Neither could he anticipate that the methods of preserving fish would, within thirty years from the date of this writing, make it not only possible but profitable for fishermen to follow their calling almost continuously during the entire year.

Michigan statistics show that in 1830 the quantity of fish marketed in the State amounted to 8,000 barrels valued at $40,000.

In 1836 the whole number of barrels taken amounted to 11,400.

In 1837, to 13,500 barrels of the value of $125,800. Of this quantity one-fourth was consumed in the State and the rest was shipped to Ohio, New York and Pennsylvania.

It will be observed that the reports of the catch and value of the commercial fish upon the Great Lakes are somewhat meagre and desultory. The report of the Detroit Board of Trade for 1857 shows that there

were between 80,000 and 100,000 barrels of fish taken in that year, valued at $640,000.

In 1885 the reports gathered by the Michigan State Board of Fish Commissioners show that the value of the commercial fish taken in the State was in value about $1,500,000 at wholesale price.

In considering such statistics as we have, we must take into account the uncertainty and unreliability that must necessarily prevail in their collection because of the want of thoroughness and completeness with which the work was done in the earlier years. So, too, we must consider in comparing one year with another the varying conditions of seasons, which is a potent factor. Severe storms may prevail one year, while the next year may be an exceedingly favorable one, and, therefore, their reliability is much impaired and the basis upon which we must make comparisons is at best unsatisfactory.

Causes of Decay.

Until about the year 1852 the fishing industry on the lakes was prosecuted almost entirely with gill-nets. Since then the gill-net fishing has continually increased until now the length of the gill-nets fished in Michigan waters alone, according to the last reliable statistics within our reach, amounts to 1,725 miles.

About the year 1850 the pound or trap-net was introduced into the Great Lakes. Its use conclusively shows that it has been one of the most destructive of fishing devices, and is responsible for the great decay of the fisheries which has been observable during the last twenty years.

Concerning the introduction of the pound-net into the Great Lakes, I am indebted to Mr. L. Anthony of Sandusky, O., for the following facts:

Pound-net fishing was first introduced by Messrs. Spencer and Courtland, two Connecticut men, at Sandusky, O., in the year 1850. The fishing with these nets

was at first done in shoal water in the bays and rivers in a depth of about 10 or 12 feet.

In 1852 Mr. L. Anthony of Sandusky, in the fall of that year began fishing with small bay nets, which was the first attempt. This fishing was done at Locust Point, between Toledo, O., and Port Clinton, Ottawa County, in the same State, in a depth of 9 feet of water. The fish were plentiful and the catch was remarkably large. He salted fifteen hundred half barrels of whitefish during this season, besides selling large quantities to the farmers, who came to the fisheries from long distances.

In the fall of 1854, Mr. Spencer, the gentleman formerly alluded to, together with other parties, including Mr. Anthony, conceived the idea that this plan of fishing could be successfully done in the deeper waters of the lakes. The first attempts was made by Mr. Anthony of deep water pound-net fishing, in the spring of 1855, at Kelly's Island and Put-in-Bay, in Lake Erie, Ohio, with marked success.

In the year 1854 he did his first pound-net fishing in Lake Huron at North Thunder Bay, fishing in 33 feet of water; fish were caught here in large quantities. There has also been some small fishing done near Lexington, Mich., which was not successful.

In the year 1856 Charles Ruggles and Capt. James Bennett fished with deep water pound-nets in Hammond's Bay, on the south shore of Lake Huron, and also on the north shore of Lake Michigan. At that time this was the largest and most successful fishery in the whole country. At the Thunder Bay fishery, on Lake Huron, Mr. Anthony caught in one net in twenty-four hours, four hundred of half barrels of whitefish. There were not one hundred pounds of other varieties caught on this occasion.

In 1865 he commenced fishing with deep water pound-nets at the Apostle Island, Madeline Island, Presque Isle, and Sand Island in Ashland Bay, off Bayfied Point,

in Lake Superior, and these fisheries resulted in a profitable investment.

From this date on the pound-net fishing increased beyond all conception. It is not infrequently the case that pound-nets are set in gangs reaching out from the shore a distance of three or or four or more miles, and the destruction of fish by this method of fishing is immense. Unquestionably the fish so taken are superior to fish taken by the gill-nets because they are preserved alive until the nets are raised, but it takes everything, great and small.

No fishculturist should condemn the taking of fish if the fishing were done with judgment and with a due regard for the future.

The iniquitous feature of the business is that the cupidity of the fisherman overcomes his better judgment, and he takes from the water large numbers of small and immature fish that are of little or no value as merchantable fish. The result of this system of fishing is most destructive, tons upon tons of fish being thus taken which have never spawned, whereas if they were permitted to remain in the water to reproduce their kind, artificial methods would be greatly aided.

About the year 1868, Mr. William Davis of Detroit, patented a freezing apparatus for the preservation of fish. In that year about sixty tons were frozen in Detroit, and seventy-five tons in Toledo. This method of preserving fish was not very kindly received at first, but gradually grew in favor. Previous to this time, during favorable seasons, large quantities of fish were taken over and above the needs of present consumption, and the only means of preserving them was by the salting process, which considerably reduced their value. Gradually the freezing process grew in favor, and it was found by experience that fish might be frozen and held in that condition for any length of time. The result has been that in almost every important town upon the lakes

which is the seat of a fishing industry, there are to-day one or more freezers with varying capacities, most of which are exceedingly large. Their erection has given a great impetus to the fishing industry. While formerly the lake fishing was prosecuted mainly in the spawning season, the methods of fishing have so changed by reason of the opportunity afforded by the freezer system of holding the fish for any length of time that now and for a number of years past fishing has been carried on in nearly every month of the year, and is only interfered with by the rigor of the season when nature closes the waters for perhaps a month or so.

Reliable statistics furnished show that the following quantities of fish were frozen from 1869 to 1884: In 1869, 400 tons; 1871, 600 tons; in 1872, 600 tons; in 1873, 700 tons; in 1874, 600 tons; in 1875, 800 tons; in 1876, 1,100 tons; in 1877, 1,200 tons; in 1878, 900 tons; in 1879, 1,100 tons; in 1880, 700 tons; in 1881, 1,100 tons; in 1882, 1,300 tons; in 1883, 1,450 tons; in 1884, 1,600 tons.

No information is at hand for the seven years from 1884 to 1892, during which years it is fair to be presumed from the general knowledge we have on the subject, these amounts were very largely increased.

The average number of tons per year for the fifteen years amounts to 1,000 tons. Averaging these fish at 2½ pounds weight apiece, the number of fish caught on an average for each year and frozen would be 800,000, and for the entire period of fifteen years it would amount to 12,000,000 fish. This takes into consideration only the fish that were frozen, and my opinion is, that if there is any error in the above figures, they are much below the actual amount. But by far the greater quantity of fish taken are sent to market, iced, fresh, but not frozen. I believe it is within reason to say that the frozen fish will not represent more than one-fifth of the total quantity taken.

When we consider this large number of fish which are being constantly taken from these lakes, we can better appreciate the serious inroads which are being made upon the supply; and when we add to this the wanton destruction of millions of small and immature fish taken that are never given an opportunity to spawn, and when we further consider the large number of gravid females, the roe of which is lost by this capture, we can begin to appreciate the problem that is set before fishculturists to restore this great loss.

Means of Arrest of Waste and Restoration.

If the wealth of the waters of the Great Lakes is to be maintained, nothing can be clearer than that this great waste, which has been going on for more than a hundred years and is increasing, must be arrested. There are two methods by which this may be effected:

1. By a liberal and lavish stocking of the waters.
2. By the enforcement of just protective laws preventing the taking and marketing of unmerchantable, young and immature fish.

As to the first point each State must act for itself in protecting its own interests in the fisheries. Weak and erratic efforts made now and then to make good the loss by the planting of a few million fish will not do. With the means at hand and with the information we now have as to fishculture, and with the small outlay of money necessary to carry on the work of artificial propagation, each State should see for itself that every female fish taken during the spawning season in its waters shall have her eggs taken from her, fecundated and after being hatched, properly planted; there is no good reason why this should not be done, and if the States whose interests are involved will take immediate steps to carry out this line of policy, they will have taken a step in the proper direction for the maintenance of their fisheries.

As to protective laws, let me say this: No laws should

be passed which should rob the fishermen of the right to follow his calling within legitimate means. If our work means anything it means that we are engaged in an undertaking which, if properly conducted, will result in a direct benefit to the fishermen and incidentally in great benefit to the people at large in the maintenance of a cheap and wholesome food. With this understanding of the conditions, fishermen should be willing to submit to such just and necessary laws as may be required to prevent destruction of young fish which are of no special value for their purposes, and the destruction of which means the ultimate decadence and extinction of their means of livelihood. So far as uniformity in laws can be secured regulating the fishing in the different States, they should be made uniform, but experience seems to indicate that the fault lies not in the number or effectiveness of statutes, but in the inadequacy of the means which have been used to enforce them.

Most of these laws are inherently defective because of the attempt to build up a warden system by counties, allowing the compensation of wardens to be fixed by the boards of supervisors, who, as a rule, will grant no compensation, or one which is grossly inadequate, which results in making the warden system of no effect. New York has without doubt the best warden law of any State in the Union, because the pay of her wardens is sure and fixed.

The ideal law would be one giving authority to the Board of Commissioners of each State to appoint a chief warden with such deputies as he might require for a proper enforcement of the laws, whose compensation should be sufficient to secure the services of good men who should be paid by the State. The State might be districted, but in that event each warden could exercise the functions of his office in some district other than the one in which he resides, thereby removing from local influence in the administration of his duty.

The States should make and enforce their own laws. No other power can do it so effectually and well. Their legislatures are familiar with the necessities of their States, are quick to respond to the wants of different localities, and by frequent contact with their constituencies know their wants.

If a general awakening of the lake States can be had as to the necessity of proper action to maintain their fisheries as above suggested, there is no reason why the great food supply furnished by these waters may not be maintained at least in their present value, with a hope of future increase.

IMPREGNATING EGGS OF THE RAINBOW TROUT.

By Wm. F. Page.

The object of this paper is to bring to the notice of this Society, and through it to the notice of fishculturists in general, a subject which has not received that degree of attention its importance would warrant; the wish is to arouse interest sufficient to lead to a correct and, if possible, a practical solution of the difficulty of impregnating the eggs of the rainbow trout.

On page 819 of the report of the U. S. Commission of Fish and Fisheries for 1882, under the report of Mr. Frank N. Clark, is the earliest record of a peculiar incident occurring in the work of impregnating the eggs of the rainbow trout. This peculiarity can not be better described than by quoting Mr. Clark's report;

"Our facilities being first-class and having been uni-
"formly successful in the propagation of trout, not ex-
"cepting the preliminary experiments with rainbow trout
"for four seasons, I had confidently expected to embry-
"onize from one to two hundred thousand eggs from the
"stock of *irideus* hatched and grown at this station; but
"we succeeded in getting only 45,000 eggs (many of the

"females failing to mature their spawn) and in fertilizing "but 15 per cent of these, resulting in a hatch of 6,400 "fish. The parent fish, of both sexes, were and still are "perfectly normal, so far as conduct and appearances "would indicate. The trouble, however, seems to have "been entirely with the females, as the quantity and "quality of the male principal was all that could be "desired. Whatever the cause of the difficulty, the effect "was at once apparent in the abnormal character of the "fluid surrounding the eggs. From most of the females "the eggs would fall into the receiving pan like shot, "accompanied by one half to one fluid ounce of watery "substance, sufficient of which had been absorbed to "prevent fertilization. If there was any doubt that "absorption of water by a large percentage of the eggs "had taken place before leaving the fish, it was dispelled "by the fact that it was quite full and hard when taken "and refused afterwards to take up any more water. "Moreover, the eggs from six females were found to be "enveloped in the natural viscous fluid, and these were "successfully fecundated."

The record above set forth refers to the spring work of 1883 at the Northville Station of the U. S. Fish Commission. Succeeding reports from this station, including the season of 1888 give varying degrees of success; ranging from 15 per cent. to 69 per cent. and averaging but 39 per cent. of impregnation during a period of six years.

When we consider the large experience and high degree of success attained by Mr. Clark as a fishculturist, we cannot help but be struck most forcibly by the seeming failure of this branch of work at Northville. But, the report quoted by Mr. Clark shows us where to search for the cause. It is to be found in those hard, distented eggs which fall into the receiving pan like shot, and are frequently accompanied by an abnormal fluid. If this trouble were confined to the Northville Station solely, it might not be considered of sufficient importance to

bring to the attention of this Society; but it is more wide-spread and destructive in its perniciousness than is generally known or supposed. There is, in fact, just reason to believe that, during the past twelve years, there has been a loss of fully ten million rainbow trout eggs to the fishculturists of the United States. Had it been possible to impregnate these ten million eggs they would have had, all things considered, a value of $18,000 to $20,000.

Whilst the trouble has proven insurmountable in Michigan, it has been serious in New York, alarming in Arkansas, and felt in no small measure in Virginia and Missouri. In Wisconsin the hard, distended eggs are not strangers (though Mr. Nevins is able to hatch 80 per cent.) And, following it Westward, it shows its hydra head in Colorado and even in California.

In his original report of this trouble Mr. Clark says; "Without attempting to account for the failure, I am "inclined to think that the fish were overfed, and that "the in-flow in their pond gave them a current quite too "slow and feeble, resulting for the most part, in great "inactivity and in their being in good condition for "market at spawning time. I propose to reduce their food "allowance to a minimum and place them in a good current "of water." Future reports do not show that these remedies were tried, though it is fair to presume they were. But, in the United States Fish Commission Report for 1885, page 126, this statement from Mr. Clark occurs; "It would seem that the species (*irideus*) will not acclima- "tize to the waters of this station (Northville, Michigan)."

These views of Mr. Clark are here given to call to your attention the theories which have been advanced and partially tried. Based on data which will follow, I believe the first two theories, "over feeding" and "insufficient current," to be erroneous.

Messrs. Annin, at Caledonia, New York; Monroe Green, at Mumford, New York; Mather, at Cold Spring

Harbor, New York; Dean, at Leadville, Colorado; Robinson, at Mammoth Spring Arkansas; and Fitzpatrick, at Chabot Lake, California; in common with Mr. Clark, at Northville, Michigan, have not averaged above 50 per cent of impregnation with the rainbow trout eggs. Mr. Seagle, of Witheville, Virginia, concedes 20 per cent. of his average take to be "hard, glassy eggs," and Mr. Nevin, of Madison, Wisconsin, acknowledges "we get a number of hard, glassy eggs." At Neosho Station, during the season just passed, 66 per cent. of our rainbow trout eggs failed to fertilize. In the transactions of the last meeting of this Society, Mr. Seal is recorded as saying: "I find that in Mexico they appear to accom-"plish more with the rainbow trout than we do here." With reference to this particular work Mr. E. Chazari writes me from the City of Mexico, under date of April 26th, 1892; "Mr. Clark's difficulty occurs among us also " * * Taking approximately the average we "have had this year 50 per cent. of the eggs borned "(spawned) sickly or bad, and at the end of the incuba-"tion, a total loss of 80 per cent." This is the result of four years old trout under domestication in Mexico. Summarizing the statements from these different sources, I am forced to the conclusion that of the whole number of rainbow trout eggs artificially spawned from domesticated fish, less than 50 per cent. are impregnated because of the impotency of the eggs to receive the fertilizing principle. At some places, in some seasons, the percentage will run higher; whilst, as has been shown, on other occasions it will fall much lower. This average of 50 per cent. is based on the work of ten hatcheries in eight states, embracing all the climatological and hydrographical conditions of the United States, except the far south, and may be modified by the accession of additional information. But I feel pretty sure, that upon fuller investigation, the statement will be confirmed rather than disproved.

During the season just passed, when studying this matter, it seemed to me unreasonable to suppose that at all of these stations an error had been made as to the proper feeding and watering of the parent stock of trout. Therefore I have discarded the theory first advanced by Mr. Clark, and began to cast about for some other ground.

During January, 1892, Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, at my earnest request sent Prof. Chas. Edw. Riley, of Drury College, Springfield, Missouri, to the Neosho Station to make a microscopic examination of the eggs and milt at the time of their extrusion. Prof. Riley made several examinations of the hard, glassy eggs, and also of the accompanying abnormal fluid. By the aid of the highest power lenses he discovered a tape-worm-like parasite in the hard eggs, and also in the accompanying abnormal fluid. No parasites whatever were found in any of the normal eggs, either dead or alive. He concludes his report of this investigation in these words; "From a careful considera-"tion of these facts I should say that some parasite had "infested the trout. It breeds on this peculiar fluid "before described, and is absorbed with the fluid before "spawning; thus causing the eggs to swell up and sound "hard when they strike the pan. I am strengthened in "this belief since apparantly the same thing was found "in the 'peculiar fluid,' in the eggs and in the water "after passing over the eggs, while the water at the supply "pipe was practically pure. I can not name the parasite, "or account for its presence."

Later in the season a series of eggs, normal and abnormal, was carefully prepared and forwarded to Prof. Riley, at Springfield, for further examination. Under date of March 24th, 1892, he wrote; "I have care-"fully examined these specimens, and in each case simply "corroborated what I found at Neosho."

Another series of specimens preserved at the same was forwarded to Washington. D. C., but unfortunately,

was so long delayed before reaching Dr. Gurley of the U. S. Fish Commission, as to be, in most cases, in an advanced state of decomposition and unserviceable for examination.

Awhile back I stated that the hard, shot-like eggs and accompanying fluid were the cause of the imperfect impregnation; but if Prof. Riley is correct, they are but an effect and the true cause is yet deeper. A study of these parasites with a view of their possible elimination opens a field which but few if any, fishculturists are prepared to tread. If further investigation confirms the impression that these parasites are present, and that to their presence is due the loss of one-half of the possible efficiency of our work with the *irideus*, we have a serious and delicate problem; one which probably only the skilled bacteriologist can handle.

Dr. Gurley has happily suggested that a simple, though heroic, cure may be found in the progressive elimination of those females producing abnormal eggs. The only practical solution may yet be found to lie in this direction. In the meantime, it would be of value if any of our spawn takers could positively state that the female rainbow trout which yield normal eggs in one season do not yield the abnormal, hard eggs in subsequent seasons. The converse of this proposition would be of equal value.

It has been suggested as a possible solution of this difficulty, that it arises from inflammation of the ovaries, established by improper and rough handling at the time of artificial spawning. From my own experience I can state that, though this suggestion may be true in some isolated cases, it is scarcely applicable to the case in general.

At the Neosho Station during the season of 1891-'92 we spawned one thousand twenty months old *irideus*. Many of the females, when handled for the very first time, readily gave down these hard, shot-like eggs without the least pressure, showing conclusively to my mind, at least

that inflammation of the ovaries, if existing, had not been occasioned by improper handling. I might here state that it is poor workmanship to use any pressure on the abdomen of a trout in taking eggs. If the fish be ripe, and she is held in proper position, she will, by her own exertion, extrude her eggs. It is true that a gentle assistance will sometimes be necessary to enable her to pass the eggs from the anterior portion of the ovary to the vent; but the exercise of enough pressure to occasion inflammation would be inexcusable. Such an amount of pressure may be; and is employed on fish caught and destined for immediate marketing, such as shad, whitefish, etc.; and, again, it is unreasonable to suppose that the exercise of pressure at one spawning sufficient to occasion inflammation of the ovaries would not result in the death of the female before the occurrence of another spawning period? Or, if not in her death, at least is such a disorded condition as would be indicated by some outward sympton?

After reading the report of Prof. Riley, as above set forth, as to the presence of parasites, I thought that they, the parasites, might have been introduced into the domesticated rainbow trout by the use of beef liver, the almost universal fish food, somewhat in the way that trichina are introduced into the human system by the use of raw pork. Working in a preliminary, amateur fashion along this line, I addressed a number of letters to prominent fish culturists, asking if they cooked the liver or used it raw. Some used raw liver; others, a mixture of raw and cooked liver; and others, a mixture of raw liver and mush. But the answer which upset my theory came from my old preceptor, Mr. Fred Mather, who had experienced the trouble of hard, glassy eggs from rainbow trout which had never been fed on any beef liver raw or cooked. Following on the heels of this came a letter from M. James Richardson, Superintendent of the California State Hatchery at Sisson. His communication contained a statement of a fact of which I had never

dreamed. He says; "Yes, I have observed, to a small "extent, the hard, glassy eggs from wild trout caught "from the streams of the Pacific slope." This so far as I am able to ascertain, is the first intimation that the hard eggs are found in these fish in their native home. It is true that Mr. Richardson says that under his observation it occurs to a small extent. Mr. Richardson's statement may be taken as a further argument against the theory of inflammation being established by rough handling. But its true significance is this; the origin of this abnormality of the *irideus* is not attributable to domestication, it exists to-day among these fish in their native state, but it seems that in domesticating them we have aggravated this abnormality. That is to say; we have, in some occult manner, given prominence to the environments that increase the propagation of the parasite discovered by Prof. Riley, and which appears to exist, to a limited extent in the female trout in her native habitat; whilst on the other hand, we are omitting something which would tend to suppress its reproduction. This being true the remedy for the trouble might be found in a condition of food and life approximating those of nature. Such may not be attainable at all points. No method seems so feasible as that employed by Mr. Gemaz of France, in his ponds for the self-reproduction of natural fish food. It would, of course, be necessary in such an undertaking to stock the ponds with proper natural food from streams from the Pacific slope; for, otherwise, that particular element which tends to maintain a healthy condition of the reproductive organs of the *irideus* might be omitted.

In conclusion, I beg to quote the following significant clause Commission for 1882; "In producing and raising "helpless infancy some of the fish tribe, art may surpass "nature; but only by a return to the ways of nature at a "period when helpfulness succeeds helplessness can the "best development come."

NATIONALISM IN STATE FISHERIES.

By C. A. Chamberlayne of Massachusetts.

Mr. Chairman and Gentlemen:

It is with very justifiable hesitancy that I ventured to address this presence I am afraid that my practical knowledge of fishculture is limited to a fascinating trout brook found in that part of Massachusetts known as Cape Cod, along the banks of which some most delightful hours of my life have been spent. I must plead guilty to a dense ignorance on the subject of those ingeniously constructed but not entirely settled *latia disepuotias* of the inhabitants, depths or shallows, for which I have constantly and so far successfully relied upon a certain commissioner from the State of Maine, who is detained from you to-day by a sickness, which he greatly regrets.

But, while it will be impossible to masquerade before you as a worthy associate in any scientific aspect for the means of national definition of approved knowledge and experience gathered here, it may still be permitted to claim such brotherhood in the great guild of friendship for the fisheries or may properly be conceded to careful consideration of the fish food supply of the country, and at least partial appreciation of the importance of its preservation, and some knowledge of certain of the obvious dangers that threaten it.

It has been suggested that a word or two might properly be said of that attempt at national legislation called the "Lapham Bill." The suggestion is a flattering one, for the Lapham Bill is interesting in itself, in its history, and still more for what it represents. It is difficult to say whether it is more worthy of examination in the legal, the scientific or the political side. What the bill proposed originally to do is not disputed. It attempted to revolutionize the control of State fisheries, to nationalize them. Its purpose was, and its effect would have been, to abrogate all important fish laws of the entire

Union, whether seaboard or inland. To be sure, it applied directly but to mackerel and menhaden, but the possibility of its passage was based upon a larger general power and none of its advocates denied the fact. After the most careful examination which I have been able to give the subject, it is, in my opinion, perfectly clear that there is not the slightest foundation for the contention that, as matter of law, Congress has the power here claimed. Nothing is clearer than that within the territorial limits of a State (that is, speaking generally, within a marine league of seashore States), it is not within the powers of Congress to abrogate or contravene a State fishing law. The contention of the friends of the bill is a most contradictory tissue of half truths and non-sequiturs, frequently even relying upon verbal quibbles and more often upon failure to give due weight to qualifying principles So far as the present state of the decisions is concerned, the rights of the States have nothing to fear from the legal aspect of the Lapham Bill.

While, however, it is satisfactory to know that Congress cannot amend State law, it is equally satisfactory to remember that it is by no means powerless in the premises. While Congress cannot abrogate State law, it can supplement and aid it. Under its power of prohibiting importation and of regulating American vessels engaged in fishing outside State limits, Congress can practically enforce a close season and probably limit the effect of destructive methods of capture by removing a profitable market or by forfeiting the Government license in case of violation, by those on board, of the Act of Congress. This power is well illustrated in the passage of the Mackerel Law of 1887, now expiring by limitation.

In further exercise of its power to regulate commerce, Congress may prohibit between States the transportation of fish which would, by the laws of any State be forfeited and by the easy process of making such offense

triable in the Courts of the United States could exercise a most valuable repressive influence against the perpetration of certain offenses against the fish and game preservation with which the States are at present dealing under great disadvantage. Legally, the situation is a good one. The State can be aided in its efforts. Its local fish laws cannot be abrogated by Federal authority.

But, while there is little ominous to the interests of the fisheries in the legal aspects of the "Lapham Bill," there is more in the persistency, skill and concentration with which the bill was urged upon Congress and with which the facts calling for its passage were insisted on. It is not too much to say that the case of the petitioners was admirably handled. Through all the ramifications of influence which could act upon legislators and committeemen, apparently every useful exertion was made for the passage of this bill. It is generally believed that the effort for the passage of the bill was visible in the Speakership contest on the occasion of the organization of the present House of Representatives, and that a pledge for the bringing forward of that particular bill procured Speaker Crisp the vote in caucus of Mr. Paige of Rhode Island, if not of other members. Many circumstances tend to bear this out. Literature of different kinds, much of it bearing evident marks of a purpose, had been prepared for months and was on hand for circulation in easily available forms. Not only was the entire membership of the United States Menhaden Oil and Guano Association stirred up to intense activity, excellently led and handled by its president, who directed operations on the spot, but allied trades having similar interests were induced to respond, its treasury was emptied into the fight.

The mackerel fishermen desiring the same objects, were joined as "silent partners" in the menhaden venture, but little argument being made in their favor, but, like other silent partners, useful in a financial point of view.

The fishmarket men of New York, Boston, Philadelphia, Portland and other cities, gave most energetic co-operation.

The net and twine corporations of New York, Baltimore, Gloucester, Boston and elsewhere, were able to add to the combined attack their estimates of the importance of removing State restrictions.

The fertilizer companies using the refuse menhaden scrap for its ammonia, ranged themselves in line. These diverse organizations not only packed the committee room on the Committee on Merchant Marine and Fisheries four successive days with a crowd of shrewd, interested. highly respectable witnesses, but exerted an immense, if indirect, influence upon the Congress. Not only were these influences and many others energetically at work, but there was an appreciable amount of brains in the management and plenty of cash to back up the brains. If any particular thing was to be said, editorially, in a newspaper, it was procured at just the right time and neatly marked in blue pencil, placed before the proper person through the most effective channel. If any Board of Trade resolution or other expression of opinion would be influential with an individual member, the meeting was held, the resolutions adopted. Some one saw that it was done. If a member could not be directly approached and his "friend" could be, the friend was ready at his elbow. Able counsel, amply supplied with funds and the consequent leisure and opportunity had spent weeks in preparation and could display those little social courtesies to members, which, with a body so large and so indifferent as Congress cannot well fail to be a force in themselves. If a reasonable *douceur* was necessary to enlist the interest of local or general newspaper reporters. the money was ready. If a Fish Commissioner of Massachusetts showed energy in opposing the bill, the man supposed to be most influential with him was able to threaten him with personal and official extinction. If a Congressman showed an unduly active

interest for the fisheries, a "back fire" was immediately attempted to be kindled in his district by arousing threatened and portentious opposition to his re-election and he was of course carefully informed through papers constantly laid on his table, of progress of the flames. Such persons as were amenable to more sordid and substantial arguments were in the hands of other agents "with the necessary funds." The shreds of legal arguments in favor of the bill were skillfully dressed and padded into a semblance of plausibility, the apparent hope being that the committee, many of whom were not lawyers, might conclude that where so much could be emphatically said, there must be at least enough to warrant an opportunity for judicial decision.

On the other hand, the wellworn arguments in favor of such an act were discriminatingly adopted to the supposed taste of the gentlemen who were asked to swallow them. The "poor man's cheap food," the "note of sport," were relied on. The petty, local nature of these State regulations, conceived in ignorance and brought forth in prejudice, was incessantly dwelt on. The advantage to farmers especially in the West and South of having the cheap fertilizer made by Mr. Bradley of Boston, from the fish scrap of Messrs. Church Bros. of Tiverton, R. I., was depicted in glowing terms. Fields of waving grain and thousands of bales of of snowy cotton grew up in plain sight of the committee under the magic wand of the petitioner's eloquence, as the necessary result of destroying the fisheries of Buzzard's, Princess and Casco bays. The miner's lamp was destined to go out; coal supply cease or advance in price; the shoe manufacturer must abandon his business, people go unshod should the ponderous wheels of Congressional legislature fail to start for the benefit of the gentlemen who had banded themselves together into the "Guano Association" for they purpose, as they euphemistically phrased it, "of steadying prices."

In these and various other ways the fine hand of good, practical management showed itself. As one of their witnesses stated, "It was either a funeral or a resurrection," and they acted accordingly. Is it to be wondered that such persistent, well directed effort accomplished results? Is it strange that when the Stenographer of the Committee was in the pay of the association that the record at critical points, such, for example, as that relating to the wishes of the fish Commissioners of the United States for assuming control of State fisheries or the "trust" nature of the Guano Association, the record has itself been materially altered and masculated? Is it a matter for surprise that six Democratic members of a Democratic House of Representatives should vote for a surrender of the rights of their States and an absolute abandonment of a distinctive principle of their party; that when the committee itself stood seven to six, a Democratic speaker of the House of Representatives should "promote" a Republican member of the majority off the committee and substitute a more available man; that a substitute bill should then be introduced substantially similar, but most dangerously misleading; that the action of the committee should then be reversed by a snap judgment, only saved from final approval by the good sense of a single man; that, finally, this decision should be reversed in the utter absence of the entire elements friendly to the bill, with the singular spectacle of a Chairman who declined to vote and only attended to make a quorum?

Is it surprising that, notwithstanding an emphatic recommendation from the Governor of Massachusetts, these netting interests should by indirection for weeks, prevent sending any official representation from Massachusetts, while charges of the bribery of several members through the lobby were continually circulated? Is it to be wondered at that a Fish Commissioner of Massachusetts saw reason suddenly to leave for home and never

return; that representatives from our fishing ports like Gloucester and from fish distributing points like Portland, Boston or New York saw good cause to support the bill? It is even unintelligible that an official of the United States should allow a confidential subordinate most disingenuously testify for the greatest fish destroying agency of modern times and himself personally to endorse a bill which would have made ignorance and ambition supplant knowledge and intelligent interest in control of the great fishing interests of the States of the Union?

With this incessant, well directed, well supported work the cause of the defenders of fisheries did not invite comparison. The disadvantage under which the public interest labors compared with private interest, showed out clearly from the first in alarming contrast. There were, of course, certain Representatives in Congress who gave consistent and loyal support to the cause of fish preservation in spite of threats and at much personal inconvenience. Messrs. Milliken and Boutelle of Maine; Hoar and Randall of Massachusetts, more especially Mr. Seth Milliken, gave their personal attendance to the hearings of the Committee and every possible assistance to the representatives of the cause. Mr. W. A. Jones of Virginia made an excellent argument against the constitutionality of the bill. In other ways and through the members, undoubtedly excellent work was done. But necessarily much of such work was disconnected and without co-operation or general direction. It was done in most cases in the interests of other business by men having large matters on hand and without the benefit of special knowledge or experience. Much of it was offset by the efforts of other Congressmen like Coggswell, Paige or Lapham in favor of the bill. Necessarily such systematic work as must be done fell to other hands and these were few and not especially practiced. Really, gentlemen, it was at first disheartening, indeed.

On the occasion of the first hearing, February 17th, 1892, the friends of the bill were able to create an atmosphere of opinion in their favor, which could not but affect the judgment of the Committee. They packed the large Committee room to suffocation; they had innumerable large delegations, representing important interests from large cities; they had excellent counsel, good stenographers, and put in an apparently overwhelming case carefully elaborated with models and figures in abundance.

On the other hand, to cross examine without any previous knowledge of their testimony, these numerous and well equipped witnesses were two solitary gentlemen from Boston and New Bedford in Massachusetts. My associate, Mr. Palmer, and myself. It is obvious that the situation is absurd. Here was the most determined, well directed assaults againt the fisheries of the States of recent years, backed with an ample treasury, under good leadership, and the defence was left almost to go by default.

Well, we did the best we could. Neither of us had any official standing before the Committee. Neither of us had any compensation, present or prospective. Mr. Palmer represented a sporting association upon Buzzards Bay, and his expenses, to a limited amount, were guaranteed by that organization. I myself represented certain towns on Buzzard's Bay, through memorials signed by their official representatives, and my expenses to a limited extent were paid by private generosity. We attended all the hearings and Mr. Palmer, at least, made some excellent points. With the adjournment of the Committee for a week at a time and their short hearings of an hour each week, the rapacity of Washington hotel keepers, soon reduced our slender appropriations. A council of war was held. Mr. Palmer decided he must go home. I determined to stay. All spare time was employed in the Congressional Library in the exanina-

tion of law, for the constitutional point seemed to be the best and strongest. Practically, I was alone. The Fish Commissioner of my own State had gone home and I was informed that there was nothing of the appropriation of $14,000 which was available for the purpose of resisting this bill, even to the extent of paying for printing an argument. I was not in funds myself for the purpose.

At this juncture something of an inspiration came to me. I remember that at one of the hearings before a packed and adverse Committee of our Massachusetts Legislature on Fisheries and Game, I had seen a Fish Commissioner for the State of Maine, Doctor Edwin W. Gould, who seemed somehow to have the idea firmly rooted in his mind, that it was part of the duty of a Fish Commissioner to preserve fish as well as propagate them. I telegraphed for him. I told him that matters were critical. He notified me to hold on and he would come on. He did so and personally I felt the situation change. He brought to the work energy, determination, an official position and some little money. The Doctor is a physician in active practice; yet for almost three consecutive weeks he staid on in Washington. The days were spent in the Congressional Library, I working on the legal, he on the scientific aspects of the question. Evenings and Sundays were spent at his hotel. The headquarters of the "Fisheries Defence" were Room 8, Hotel Hamilton, Washington, D. C., for weeks. A brief on the law and a memorial of facts were prepared, printed at the expense of the State of Maine, submitted to Congress and distributed through the country. We desired to visit certain places on the coast, New Jersey, Virginia or Maryland, to enlist support we were sure to find, but the funds were not sufficient. What could be done in other States through the mails we did, and valuable results followed, as we have ventured to hope. From this or other causes, representatives began to hear

from their constituents hitherto silent. The Massachusetts Legislature sent on the Attorney General and an agent, both of whom were to act without compensation and rely for their expenses upon the capacity of the contingent fund.

The Attorney General of Maine consequently addressed the Committee against the bill. By these and other influences, the bill met its fate.

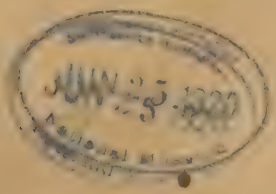
The "Lapham Bill" will have served a most useful purpose if it emphasizes the danger to the fisheries from this quarter and suggests the remedy for their protection. The danger is in those opposing disciplined troops of gorilla warfare; the remedy is in the hands of admirable organizations such as yours, and lies in solidifying the interests of the country for the preservation of its fish supply of food.

Division of Fishes,
U. S. National Museum

TRANSACTIONS

AMERICAN FISHERIES SOCIETY

1893



TRANSACTIONS

OF THE

AMERICAN

FISHERIES SOCIETY.

TWENTY-SECOND ANNUAL MEETING.

HELD IN THE

MICHIGAN STATE BUILDING,

JACKSON PARK, CHICAGO, ILL.

JULY 15TH, 1893.

NEW YORK:
John M. Davis, Typographer, 40 Fulton Street.

1893.

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A. B. FRENCH ....*South Braintree, Mass.*

HERSCHEL WHITAKER ....*Detroit, Mich.*

MINUTES

—OF THE—

TWENTY-SECOND ANNUAL MEETING

—OF THE—

AMERICAN FISHERIES SOCIETY.

PART FIRST.

The meeting was called to order by the President, Hon. Herschel Whitaker, of Michigan; the following members being present:

A. Booth,	Illinois.
L. D. Huntington,	New York.
William H. Bowman,	New York.
Robert Hamilton,	New York.
A. S. Joline,	New York.
William C. Butts,	New York.
David Decker,	New York.
G. Freas,	Pennsylvania.
Charles L. Heins,	New Jersey.
Henry C. Ford,	Pennsylvania.
W. L Gilbert,	Massachusetts.
William L. Powell,	Pennsylvania.
William F. Page,	Missouri.
W. S. de Ravenel,	South Carolina.
Dr. Tarleton H. Bean,	Washington, D. C.
Frank N. Clark,	Michigan.
Herschel Whitaker,	Michigan.
Hoyt Post,	Michigan.

Dr. Jacob Reighard,	Michigan.
William L. May,	Nebraska.
Edward P. Doyle,	New York.
Charles Wyeth,	New York.
Fred Mather,	New York.
Dr. J. A. Henshall,	Ohio.
Dr. H. H. Cary,	Georgia.
H. W. Davis,	Michigan.
W. David Tomlin,	Minnesota.
C. E. Armstrong,	Ohio.
Joseph H. Blair,	Nebraska.
J. C. Parker,	Michigan.
J. W. Collins,	Washington, D. C.
James Nevins,	Wisconsin.
John Gay,	Pennsylvania.
B. R. Vincent,	Ohio.
Dr. R. O. Sweeny,	Minnesota.
Dr. Nicholas Borodine,	Russia.
Asa French,	Massachusetts.
Dr. William M. Hudson,	Connecticut.
H. C. Demuth,	Pennsylvania.
L. Streuber,	Pennsylvania.

After the roll was called, the President addressed the members as follows:

Gentlemen of the American Fisheries Society:

We meet to-day to participate in the work that may properly come before us at our twenty-second annual gathering. While the Society changed its name some years since from the Fishcultural Society to its present name of the American Fisheries Society, its personnel remains practically the same as before the change, and notwithstanding its change of name may be considered as having had one continuous existence from its original inception. The object sought in the change of name was to give to the title under which it was known a broader and more comprehensive scope, and to admit not only those who were fishculturists but those who, while not actively engaged in fishcultural work, were interested and active workers in matters closely allied with fishculture. The wisdom of the

change has been fully justified by the addition of such persons, who have proven useful members.

The formation of the Society was coeval with the introduction of practical fishculture into this country, and the necessity of such an organization as a useful aid to fishculture, in the opinion of those who organized it, has been fully justified by its history. Its originally expressed object was to bring together, for consultation and into closer relationship, those who were interested in fishculture, directly and indirectly. Those purposes have been fully subserved by the Society in all its past history, and the published records of its proceedings from year to year furnishes a record of the current advance that has been made from year to year in the work of artificial propagation, the stocking of waters and the advance in fishcultural work. The papers submitted at its meetings on subjects of interest have been of great value, elicited discussion, and brought out new ideas which have been of advantage.

There is perhaps no country in which the importance of fishculture has been so generally recognized as in the United States. The commercial value of our sea and lake fisheries is very important, and the decay resulting from a long and protracted course of fishing, first challenged attention of the people to the institution by means of which the waste might be corrected and the loss made good. The general Government and the State Governments more than twenty years ago recognized the benefits to be derived from the work of artificial propagation, and at once commenced the establishment of hatcheries, and have since liberally voted money for the establishment and maintenance of fishcultural work in the various States.

The work of the Fish Commissions in this country has up to this time been mainly directed to the propagation and planting of fish in the sea, lakes and streams. This work has been most successful, and the waters thus planted are a standing object lesson of the value of this undertaking.

It would seem, however, when we come to consider the status of the work of our different Commissions, and the progress they have made in the propagation of commercial fish, that the time has now come when Commissions should, in connection with their other work, take up the equally important matter of investigation into the food of the fishes, and should direct their attention to this subject, which is of the highest importance to the success of all fish-cultural work.

While something has already been done in this direction in this country, the work has been of a rather desultory and fugitive character, and has not been carried out upon a well-considered plan. We grant that it is important that the fishculturist should hatch fish, and hatch them in large numbers, but is it not of equal importance that he should know the character and amount of the food of young fish contained in the waters in which they are put? Is it not of greatest consequence that he should know whether this food abounds more plentifully in one locality, or at one season of the year than at another? Is it not material to the success of his work that the fishculturist should know whether his "presumption" that the food of the young fish is to be found plentifully upon the natural spawning beds should be verified, and if it is not so, where it may be found in greatest abundance? This being admitted, is it not essential that he should know the precise localities of every spawning bed of the commercial fish beyond a doubt? In other words, our information should not depend upon uncertain information that is based upon the local traditions of practical fishermen as to the location of spawning beds. While such information may be sufficiently accurate for the fisherman's purpose, it may be absolutely worthless to the fishculturist in determining their exact location. In the trial of a suit at law, secondary or hearsay evidence is never admissible to determine a fact, and yet the admission of such evidence in a law suit would not be productive

of half the evil which would follow such poor proof of so important a fact to be determined in the work of a Commission which seeks to do its work effectively. Then, too, why should not the fishculturist know more nearly and exactly by sight the whitefish and other commercial fish of our great lakes at every stage of their growth, from the fry age to that time when their identity can be easily established by the most casual observer? With such knowledge, we might know with greater certainty the rate of growth of these fish, and we might also be able to definitely determine their movements in the great lakes throughout the entire year. It would be of interest and a valuable addition to our knowledge, to know how long the young fish remain upon the spawning beds, and at what period they leave them, where they go in search of food, and upon what they live after leaving them. These and other matters of equal importance challenge the attention of thoughtful fishculturists, who keep in view a successful result of their work; and it is clearly not only within the province of the fishculturists and of Fish Commissions to settle these questions, but it is their clear duty. The successful solution of these matters will serve to equip us with valuable information that will aid largely in arriving at the best practical results at which we aim.

Greater attention should also be given to the planting or stocking of our inland waters, and the manner in which this work shall be performed. Systematic and comprehensive examinations should be made of the lakes and streams, to determine their character, temperature, depth and the character of the fish food which they sustain. Too much stress cannot be laid upon the value of such examination. Only by this method of inquiry can intelligent stocking of waters be done. The fishculturist who wishes to act for the best interests of his work must act intelligently in making his distributions. The character of the work in which he is engaged and its results depend upon his care

in making his plants, and if he knows his waters, what they contain, and for what they are suited, he can secure a larger measure of success.

This work of examination, if carefully made and correctly reported and filed, is invaluable for future reference, and is of the greatest aid in making future distributions. A reference to such report at once discloses whether the kinds of fish applied for are fitted for the waters mentioned in the application. If they are not, the grounds of refusal are at hand by which the applicant may be convinced of his mistake, and fish suitable for his waters can thus be furnished him.

The attention of most of our Fish Commissions has up to this time been chiefly directed to the propagation and distribution of the finer edible varieties of fish of the salmon family. The ova of these fish is easily treated, and presents but few obstacles to their manipulation, and a large percentage of fertilization is secured. No fault can be found with the carrying on of this work, and it is of the utmost importance that it should be continued and enlarged, but we should not rest contented with this work alone. A broader field than this is open to the fishculturist, and cannot be entered upon too soon. Many of our spring spawning fish are of great value commercially, others of excellent quality are objects of the angler's pursuit, and are among the best fish which our inland waters produce. The exceeding viscidity of their ova presents difficulties to successful handling when artificially impregnated, but the value of these fish, and the necessity that they should be objects of the fishculturist's attention, should urge us to give them the attention they demand. The physical difficulties to be overcome in the treatment of the ova renders it difficult and sometimes discouraging to the operator, but these difficulties it is the duty of the fishculturist to overcome. The popularity of the small-mouthed black bass as the game fish of our inland lakes

and streams, has led to an over-fishing in some of our older States, and in our most accessible waters, and a consequent scarcity of fish. This fish is worthy of the best attention of Commissioners, and should receive attention at our hands.

In overcoming the difficulties I have spoken of, and the resulting low percentage of success which has attended such few experimental efforts as have been made, we can with profit call in the co-operation of the scientist to aid our practical force of fishculturists, who will tell why they meet with only partial success in present methods in the manipulation of the fish and the treatment of the ova. He will be able to point out, with the aid of the microscope and a higher education and sharpened intelligence, the causes which result in low impregnation, and the way in which present methods may be improved.

Much has been done in the past few years in attempts to successfully introduce into our waters foreign species of fish, and while these efforts should not be too harshly criticised, it may be said that outside of one or two varieties thus introduced, this work has been unsuccessful. The experiments have been of but little practical value when we count results. It must appeal to the average judgment after all, it would seem, that if an equal amount of effort, time and means had been devoted to the increase of the native fish which we have that are deserving of care and attention and multiplication, the money, time and effort would have been more practically spent. These indigenoush fish are natural to our waters, are of excellent character; it is no experiment to determine whether they will live and thrive. They do not require to be adapted to strange conditions and new surroundings. Is it not better practical fishculture to increase the good varieties that we have, than to go too far into the field of experimentation? It would seem that the office and function of a Fish Commission is best fulfilled when it gives its attention to the

increase of those fish natural to our waters, rather than to attempt to solve unsolvable or difficult questions which have but little practical value.

The probabilities of fishculture in America are great. With well-directed effort, every lake, stream and river can be made to produce a plentiful supply of fish, which are best suited to their condition, thus furnishing a large and important supply of food which will not require the hand of man to assist in its cultivation. To accomplish this purpose, it seems to me, is the enlarged field which every Commission is invited to enter. This is the field which modern fishculture, based on enlarged ideas of public work, may occupy with profit. The American Fisheries Society is the proper forum in which these and kindred questions should be mooted and discussed. Modern fishculture needs to take another step in advance, and if it shall live up to its possibilities, the members of this Society, at their annual gathering two decades hence, will point to a far greater advance in the work of fishculture than we have accomplished in the two decades that have just passed.

Henry C. Ford, of Pennsylvania, the Treasurer of the Association, then presented his annual report, which, upon motion, was referred to an Auditing Committee of three, to be appointed by the Chair ; the Chair appointed as such Committee: Henry H. Cary, of Georgia, John Gay, of Pennsylvania, and J. E. Gunckel, of Ohio. The Recording Secretary then presented his annual report, which, upon motion, was ordered printed upon the minutes. The report was as follows :

Gentlemen of the American Fisheries Society :

During the past year the Society lost six members by death and eight by resignation ; forty-nine new members were elected ; the present membership is, corresponding members 30 ; honorary members 6 ; active members 255.

Agreeable to your resolution of last meeting, I notified the Commissioners of Fisheries of each State in the Union that they had been elected members of the Society, by virtue of the offices they held. In my letter I requested that they answer my communication, accepting or declining membership. The answers received were all favorable, and every Fish Commissioner of the United States is now a member of the American Fisheries Society.

Circulars were also sent out liberally to all persons interested in fish and game, but the responses were but few. It is very desirable that the membership of the Society shall be increased, and means to that end should be at once taken. As the membership of the Society grows larger, the circle of its influence will widen, and the sphere of its usefulness extend. It can be made the most important factor in the advancement of fish and game interests of the country.

EDWARD P. DOYLE,
Secretary.

On motion, the report was received and referred to a special committee of three, to be appointed by the President, with full power to act in the premises. The President appointed as such Committee Dr. H. H. Cary, of Georgia, John Gay, of Pennsylvania, and J. E. Gunckel, of Ohio.

The reading of papers then began. The first paper read was by Fred Mather, Superintendent of the Cold Spring Harbor Station of the New York Fish Commission, and was entitled "What we Know About Lobsters." The discussion aroused by this and subsequent papers will be found printed in the Appendix to the report. The next paper was by J. D. Quackenbos, A.M., M.D., on the Sunapee Saibling. The next paper was by Hon. Hoyt Post, of Michigan, entitled "An Historical Review of Fish Culture in Michigan." Prof. Jacob Reighard then read a paper entitled "Handling of Adhesive Eggs." A paper by W.

David Tomlin, entitled "The Specialist in Fish Culture," was announced by title but not read.

William F. Page, of Missouri, read a paper entitled "Plant Yearlings Where Needed." At this point, the reading of papers was suspended, and on motion, W. L. May, of Nebraska, L. D. Huntington, of New York, and W. H. Davis, of Michigan, were appointed a Committee to consider the question of the selection of a place for the next meeting of the Society. Hon. L. D. Huntington offered the following resolution, which, upon motion, was unanimously adopted:

Resolved, That there be entered upon the minutes of this meeting an expression of the thanks of this Society to the World's Fair Commissioners of the State of Michigan for their kindness in allowing the Society the use of so spacious a room for their meeting.

A paper by E. W. Gould, who was absent, was announced to be read by title. This occasioned considerable discussion, and upon motion, it was *Resolved*, That papers read by title be referred to a Committee on Publication, consisting of three, the President, the Secretary, and another, to be appointed by the President.

A paper was then read on Pearl Fisheries by Prof. Kunz. On motion, it was *Resolved*, That the paper of Prof. Kunz be printed with illustrations. On motion, a committee of five was appointed to present nominations for officers for the Society, for the ensuing year, the committee to be appointed by the President. The President appointed as such Committee, Dr. H. H. Cary, of Georgia, William H. Bowman, of New York, John Gay, of Pennsylvania, R. O. Sweeny, of Minnesota, W. L. May, of Nebraska.

On motion, a recess was taken until 2.30.

ADJOURNED MEETING AMERICAN FISHERIES SOCIETY, HELD IN JACKSON PARK, CHICAGO, THURSDAY, JUNE 15TH, AT 2.30 P. M.

Immediately after the meeting was called to order, the

President informed the Society that Capt. J. W. Collins, Chief of the Department of Fish and Fisheries, had invited the members to visit the Fisheries Building. Capt. Collins said that the Russian Commissioner would show and explain his collection. He also desired to call especial attention to the rare exhibit of fish and boats, never before seen at former Expositions. The President also announced that Mr. Kunz, of Tiffany & Co., who read a paper on Pearl Fisheries, invited the Society to visit the exhibit of Tiffany & Co., and examine the collection of Oriental pearls. On motion, both invitations were accepted :

The Committee appointed to audit the accounts of the Treasurer, then presented the following report :

AMERICAN FISHERIES SOCIETY
IN ACCOUNT WITH
H. C. FORD, Treasurer, June 1st, 1893.

1892.	*Credits.*		
May 25.	By balance on hand.....		$217.73
	By cash, dues received from members to June 1st, 1893.....		321.00
	Total.....		$538.73
1892.	*Debits.*		
May 25.	To cash paid E. P. Doyle, for disbursements.....	$ 15.65	
June 13.	To cash Spangler & Davis, for printing.....	1.25	
July 8.	John Standfast, stenographer.....	50.00	
Aug. 6.	Mary Walling, typewriter	37.67	
Oct. 10.	D. S. Walton & Co., for sundry bills	20.80	
Dec. 23.	D. S. Walton & Co., for printing report.....	343.00	
1893.			
Jan. 20.	Postage stamps, etc.....	3.50	
June 1.	Balance in hands of Treas.	66.86	$538.73

The Auditing Committee having examined the above report, and accompanying vouchers, find the same correct.

All of which is respectfully submitted.

H. H. Cary, Chairman,
John Gay,
J. E. Gunckel,
} Auditing Committee.

The following papers were then read: "A Statistical Review of Fish Culture in the United States and in Europe," by Dr. Nicholas Borodine, of Russia. A paper on "Norwegian Fisheries" was read by Chr. Ravn, Royal Commissioner from Norway.

On motion, a recess was taken until 2.30 in the afternoon.

Minutes of Adjourned Meeting American Fisheries Society, held Friday, July 16th, at 2.30 p. m.

After the meeting was called to order, Dr. Cary, from the Committee on Nominations, presented the following report:

"Your Committee on Nominations beg leave to submit the following names as candidates for officers of the Society for the ensuing year: For President, Henry C. Ford, of Pennsylvania; for Vice-President, Fred Mather, of New York; for Treasurer, R. Ormsby Sweeny, of Minnesota; for Recording Secretary, Edward P. Doyle, of New York; for Corresponding Secretary, Dr. J. A. Henshall, of Ohio. Executive Committee: H. H. Cary, La Grange, Ga.; L. D. Huntington, New Rochelle, N. Y.; L. Streuber, Erie, Pa.; W. L. May, Omaha, Neb.; James Nevin, Madison, Wis.; J. E. Gunckel, Toledo, O.; A. B. French, South Braintree, Mass.; Herschel Whitaker, Detroit, Mich."

On motion, the report of the Committee was received and adopted, and the persons named unanimously chosen as officers for the Society for the ensuing year.

Dr. Tarleton H. Bean presented the following resolution, which, upon motion, was lost:

"*Resolved*, That nominations of officers of the American

Fisheries Society be made in open meeting and that elections be had by ballot."

The Recording Secretary called attention to the fact that he had inadvertently printed in the preceding report a paper by Charles F. Chamberlain, of Massachusetts, reflecting upon several members of the Society.

On motion, a resolution of thanks was adopted, thanking Capt. J. W. Collins for the excellent dinner he had provided for the members.

Mr. Huntington, of New York, from the Committee on Site and Date for the next meeting, reported in favor of Philadelphia as the place of meeting, and the third Wednesday in May as the date. Dr. Tarleton H. Bean, of Washington, moved a division of the question, which was carried. The question then was, "Shall Philadelphia be adopted as the place of meeting?" The question was carried. The third Wednesday in May was then adopted as the time for the meeting.

The following gentlemen were then elected members of the Society: Honorary, Nicholas Borodine, Delegate of the Russian Association of Pisciculture and Fisheries, St. Petersburg, Russia. Active members, Dr. Bashford Dean, Columbia College, New York; C. E. Armstrong, Toledo, Ohio; Joseph H. Blair, Omaha, Nebraska; W. de C. Ravenel; Alexander Jones, Wood's Holl, Massachusetts; H. W. Davis, of Detroit, Michigan.

PAPERS READ BEFORE THE

AMERICAN FISHERIES SOCIETY,

WITH THEIR DISCUSSIONS,

JULY 15TH, 1893.

PART SECOND.

ON THE OCCURRENCE OF PEARLS IN THE UNITED STATES, AND SHALL WE LEGISLATE TO PRESERVE THE FISHERIES.

BY GEORGE FREDERIC KUNZ.

Pearls are lustrous concretions, consisting essentially of carbonate of lime interlaminated with animal matter, found in the shells of certain mollusks. They are evidently a result of an abnormal secretory process caused by an irritation of the mantle of the mollusk consequent on the intrusion into the shell of some foreign body, as a grain of sand, an egg of the mollusk itself, or perhaps a cercarian parasite. It has also been suggested than an excess of carbonate of lime in the water may cause the development of the pearl. Accepting the former theory as the more probable one, it is easy to understand how a foreign body, which the mollusk is unable to expel, becomes encysted

or covered as by a capsule, which gradually thickens and assumes various forms—round, elongated, mallet-shaped, and sometimes as regular as though it had been turned in a lathe. It is suggested that the mollusk continually revolves the enclosed particle in its efforts to rid itself of the irritation, or possibly that its formation is due to natural motion, which is accelerated by the intruding body.

In regard to the formation of pearls the following general statements may be made: Whatever may be the cause, or the process of their production, these interior concretions may occur in almost any molluscan shells, though they are confined to certain groups, and their color and lustre depend upon those of the shell interior, adjacent to which they are formed. Thus the pink conch of the West Indies yields beautiful rose-colored pearl shells consisting of three strata: first, the outer yellow or brown conchioline (cuticula or epidermis); second, the prism stratum, consisting of layers formed of minute prisms arranged vertically to the layers and the shell surface; and third, the interior nacreous layer, composed of finely folded leaves parallel to the surface of the shell. The last two strata consist chiefly of carbonate of lime. These formations were illustrated by transverse cuttings and microscopic sections. When a wound has been received by the animal in any soft part, the tissues become moistened with a lime-like material, and especially with the nacre substance. This often happens in the muscles which serve to close the shell, and the irregular concretions thus formed are called "sand pearls." When the growth of the pearl is abnormally strong, the pressure which it exerts on the outer wall of this tissue-pocket becomes so powerful that the pocket is absorbed on the side toward the shell, bringing the hard pearl directly against the latter. It then becomes impossible for the pearl to grow any more at the point of contact, for there is no tissue to secrete the lime substance; but it grows on the rest of the surface, and the

thickening layers, as they are formed, pass directly into the nacre layers on the inside of the shell, and thicken the shell itself. Through these over-layers the pearl is connected with the shell as though by a succession of covering clothes. At first it clings to the shell at one point only, afterward enlarging the area of its adhesion. In this manner twin or united pearls are formed. Whatever be the method of their formation, it would seem that pearls can be formed only at the expense of the shell, for every substance necessary to their growth is drawn from sources which normally secrete the shell. Hence the presence of the pearl can usually be detected on the outside of the shell. Normal appearing shells rarely contain pearls, while on the other hand those that are deformed often contain pearls of great beauty. There are three indications on which pearl-fishers rely for detecting from the outer aspect of the shell the presence of pearls. These are: first, the thread, that is, the recess of elevation extending from the vertex to the edge; second, the kidney-shape of the shell, that is, an indentation on the ventral side; and third, the contortion of both shells toward the middle plane of the animal.

The families with iridescent interior layers are the following: Among cephalopods, the Nautilus and Ammonite groups, the latter wholly fossil, and among gasteropods, the Turbo and Haliotis families. In all these forms, the removal of the outer layers of the shell reveals the splendid pearly surface beneath. Such shells, thus "cleaned" with dilute acid, are familiar as ornamental objects, while those of the common oyster and clam are dead white or dark purple, according to their proximity to the part of the mantle which secretes the white or the dark material of the shell. The true pearly or nacreous (iridescent) interior belongs to only a few families of mollusks, and in these alone can pearls proper be formed at all; while in

point of fact they are obtained only from a very few genera of shells.

None of the air-breathing mollusks (the land snails) produce a nacreous shell; and among fresh-water mollusks none are pearl-bearers, except certain of the bivalves, notably those belonging to the group appropriately called the Naiades, of which the common river-mussel (Unio) is a typical example. The soft internal parts of these mollusks are covered by a thin, delicate membrane called the mantle, from the surface of which and particularly from its outer edge, material is excreted to form the inner layers of the shell. The shell consists of two parts, the epidermis and the shell proper, the latter composed of numerous layers. The epidermis, which resembles horn, is chiefly composed of a substance called "conchioline," and is soluble in caustic alkalies.

The pearls of commerce, however, are almost wholly obtained from bivalve (lamellibranch) shells, of which the following families have a nacreous lining: Aviculidæ, Mytilidæ and Unionidæ, the latter being wholly fresh-water shells, also known as the Naiades. A few families of other genera are also brilliantly pearly, but need not be here discussed. The true pearl oyster (Meleagrina) of the Pacific and Indian Oceans belongs to the first of these groups, and has from time immemorial yielded the bulk of commercial pearls, while its large and thick shell furnishes the mother-of-pearl for countless ornamental purposes.

The Naiades are of particular interest in this country, as it is in North America that this group is the most abundant, and it is only of the occurrence of pearls, and the preservation of the fisheries of the United States, that my paper will treat. Many hundred species of Unio, Anodon, etc., have been found in our great rivers and lakes; the Mississippi basin teems with them; for the most part in forms quite distinct from those of the Atlantic

water-shed and of the Old World. The Unios, while all iridescent, vary greatly in tint, exhibiting all the delicate shades of pink, brown, purple, etc., as well as white. The rivers of Europe, of Mesopotamia and of China, also yield large numbers of Unios; while the allied genera Hyria and Castalia are found in the rivers of South America.

The same causes and operations that result in the production of pearls, or free nacreous concretions in the soft animal substance of the pearl-oysters or mother-of-pearl shells, also produce in a modified way the tuberculous or knob-like protuberances and irregularities of surface that are frequently seen on the pearly inner surface of the valves and projecting therefrom. The flatter or less pronounced forms of these nacreous excrescences are often called "blister pearls," because of their resemblance to vesicular eruptions, or water blister, caused by burns.

Fresh-water pearls are found, as before stated, in various species of Unios, more frequently, according to Dr. Isaac Lea, in the Unio complanatus, but also in the following: U. blandianus, U. buddianus, U. costatus, U. elliotti, U. fragilis, U. globulus, U. gracilis, U. mortoni, U. nodosus, U. orbiculatus, U. ovatus, U. torsus, U. undulatus and U. virginianus. Not one pearl in a hundred from the Unios is of good shape, and probably not more than one in a hundred is really fine; therefore, as the worth of a pearl depends on lustre and form, the greater number obtained from this source are of slight value.

A hundred pearls have been found in a single shell; but as a rule these have little or no value. Very curious nacreous groups made of many small pieces are at times found attached to the hinge, but these are generally without sufficient lustre to be of value, and are rarely collected. These groups are caused by the aggregation of many small ones cemented by a deposit of nacre, and are often half an inch across.

In color, the Unio pearl presents an extended series of

shades, from dead opaque white, having but little value, through various tints of pink, yellow and salmon, passing through a more decided form of these colors, or a faint purple, into a bright red, so closely resembling a drop of molten copper as almost to deceive the eye. Some are very light green and brown, others rose-color, and still others are pale steel-blue, or russet and purplish brown. The white and the pink pearls are exceedingly beautiful, and the finest, owing to their delicate sheen or layers, are at times more lustrous than even the best oriental pearls. This lustre is increased by their greater transparency, and a really fine white, pink, yellow or iridescent pearl is often found quite translucent. In addition to their color and lustre, they are beautifully iridescent. They are found in many odd and remarkable shapes.

Elongated fish-like forms, formed and found near the hinge of the shell, and called hinge baroque pearls, are abundant. Others, with but a slight addition of gold and enamel, seem to represent human and animal heads, bat and bird wings, and similar objects. Mallet-shaped pearls are found with fine color and lustre at each end, but generally with opaque sides; also grouped or bunched masses of pearly nacre, made up of from one to over one hundred distinct pearls in fanciful shapes, are of occasional occurrence. Feather-like forms with curiously raised points, and an odd, rounded variety with raised, pitted markings, are quite abundant. A pearl was mounted in this country that strikingly resembles the bust of Michael Angelo, and a number of unique designs have been made of baroques, similar to those mounted by Dinglinger and exhibited in the Green Vaults at Dresden. Although the pearls used here have not been as large as those shown in Dresden, greater taste has been employed in mounting them. The variety of the forms being so great, an artist has a wide field for imagination. The pearls, however, have but slight value unless they are beautiful and lustrous.

Frequently pearls have an opaque appearance and seem to be worthless, but upon the removal of their outer layer are found to be clear and iridescent. This outer layer may be removed by dipping them in a weak solution of acid, which dissolves the opaque coating, or it may be peeled with a knife; although sometimes the pearl is not of the same material throughout and cannot be.

That conchologists make so few references to pearls is probably accounted for by the fact that the pearls are contained in old, distorted and diseased shells, which are not so desirable for collections as the finer specimens. Collectors who have opened many thousands of Unios have never observed a pearl of value.

Large and valuable Unio pearls have been obtained in New Jersey. In 1857 a pearl of fine lustre, weighing 93 grains, was found at Notch Brook, near Paterson. It became known as the "Queen Pearl," and was sold by Tiffany & Co. to the Empress Eugenie of France for $2,500. It is to-day worth more than four times that amount, and is finer than any pearl shown at the 1893 World's Columbian Exposition. The news of this sale created the first great pearl excitement that led to the search for pearls which spread westward throughout the country. The Unios at Notch Brook and elsewhere were gathered by millions and destroyed, often with little or no result. A large round pearl weighing 400 grains, which would doubtless have been the finest pearl of modern times, was ruined by boiling open the shell.

Within one year pearls were sent to the New York market from nearly every State. In 1857 fully $15,000 worth; in 1858 about $2,000; in 1859 about $2,000; in 1860 about $1,500; in 1868, when there was a slight revival of interest, and since then, many Little Miami River pearls have been found. Since 1860, pearls have come from a comparatively new district, the supply from which is apparently on the increase. At first few were found, or rather few were

looked for, west of Ohio; but gradually the line has extended to Kentucky, Tennessee and Texas; and now Wisconsin is the principal pearl-producing State; while some pearls are sent from Florida, Nebraska and Washington State.

Some of the earliest American pearls that were found came from near Waynesville, Ohio; $3,000 worth having been collected in that vicinity during the pearl excitement in 1878. At that time Israel H. Harris, of Waynesville, began what has since become one of the finest and best known collections of Unio pearls in this country, purchasing, during many years, every specimen of value that he could find in that part of the State. Among his pearls was one button-shaped on the back and weighing 38 grains, also several almost transparent pink ones, and an interesting specimen showing where a pearl had grown almost entirely through the Unio shell. His collection contained more than 2,000 pearls, weighing over 2,000 grains, and is in all probability the last collection that will be made from that district. It was exhibited in the Jewelry Department at the World's Fair in Paris, in 1889.

A pearl from Montpelier, Vermont, was sold for $300; one from Waynesville, Ohio, valued at $200; one from Boston, Texas, valued at $250; one pink pearl, 19½ grains, from Murfreesborough, Tennessee, valued at $80, another at $150; one from Llano, Texas, valued at $95, have been sold in New York.

The production during recent years has been as follows:

September, 1881 to 1882.....210 lots worth $7,500
September, 1882 to 1883..... 72 lots worth $5,000
September, 1883, to August, 1884, 71 lots worth $5,000

American pearls, until within the past few years, were generally sold at a figure below their real value, and the values of the above to-day would be fully two or three times those amounts; and at present the local value is often exaggerated several times above their true value.

Since 1889, pearl fishing in Wisconsin has been extensively carried on along the Pecatonica River and the creeks emptying into it, principally between Darlington and Argyle, Lafayette County, as well as on Apple River. Many fine pearls, remarkable for brilliancy and lustre, have been obtained, among them some of the finest copper-colored, russet, purple and rich pink tints ever found. Some simple pearls weigh over 50 grains, and the finest ones command from $500 to over $1,000 each. It has been estimated that over $300,000 worth of pearls have been found in the course of the past few years; the pearls frequently commanding higher prices here than the oriental pearls, and as a result, pearls sent abroad were returned, the prices being abnormally higher than the foreign markets would pay.

Some of the finest pieces of jewelry shown at the World's Columbian Exposition were made of American pearls and American precious stones. A fine collection was on exhibition in the Wisconsin Exhibit of the Mines and Mining Building, World's Columbian Exposition; the value of this collection was estimated at over $100,000; but the prices were somewhat fancy ones, induced by local demand.

During the summer of 1890, the pearl excitement extended to Marnitowoc County, Wisconsin, and numerous small lakes that lie in Calumet County. From one to fifty pearls have been found in a single Unio. When numerous, they are usually hinge pearls. As in the former times of excitement, hundreds of men, women and children made trips to these creeks; the men and boys removing the shells from the river, while the women and girls opened them.

In the same year the pearl-hunting fever extended along the Mackinaw River and the creeks running into it in McLean, Tazewell and Woodford Counties, Illinois. Pearls have also been found in the vicinity of Traer and Geneseo,

on Wolf Creek, Iowa. A fine pink pearl was found near Walla Walla, Washington State, and a number have been sold at Seattle, Washington.

One of the most singular circumstances connected with the New Jersey "pearl fever" of 1856 was the discovery of several shells which proved that the local savants had experimented on the pearl-bearing Unios by dropping mother-of-pearl buttons inside the shell, hoping that the mussel would cover them with its secretions. The specimens found had apparently been experimented on over 30 years before, at a time when European scientists were greatly interested in shells received from China, containing small images of Buddha. These images were moulded in tin and placed between the mantle and the shell. The mussels were then returned to their natural environment, and after several months the layer of mother-of-pearl became of sufficient thickness, and the images were removed.

In a shell of the Lea Collection of Unionidæ, which has recently been presented to the United States National Museum, an oval piece of white wax, flat on the lower side and rounded on the upper, which had been inserted in the valve near the hinge, is entirely coated with a pink nacre. It has been broken out of the shell, the pearly nacre of the lower or flat side remaining in the shell; whereas the dome-shaped piece is covered with this material.

The writer knew a New York lady who purchased a button-shaped Unio pearl that had a black, diseased appearance on one side. It was so set that the imperfection was all below the mounting. When applauding at the opera one evening, the pearl was broken, and upon examination it was found to consist of a very thin nacreous layer, inside of which was nothing but a hard, white, greasy clay.

At the International Fisheries Exhibition held in Berlin during 1880, there were shown results of experiments under-

taken in Germany, toward the production of artificial pearls from Unios, in a manner similar to that practiced by the Chinese. Flat tin figures, usually of fish, were introduced between the mantle and the shell. Similar experiments were conducted in the Royal Saxon pearl fisheries. Either small foreign bodies were introduced into the mantle, in order to furnish the nucleus for the free pearl formation, or the Chinese method of inserting such bodies between the mantle and the shell, was followed. From the second method successful results were shown. The foreign bodies that had been introduced were poor pearls from other mussels, pieces of grain, or china buttons, and were entirely covered with nacreous substance. The shape of these objects makes it impossible for the mantle to fit closely around them, and hence the nacre covers them so irregularly that little or no use can be made of them, and ornamental devices coated with a beautiful nacre would undoubtedly find ready purchasers at a fair price. From specimens exhibited, it was shown that German oysters could be made to cover a plain relief with nacre, as well as those of China. The cultivation of such forms in this country might lead to considerable income; and the brooks could be as easily protected as trout brooks or ponds are.

Efforts to make the river pearl mussel available in another way met with better success, and are worthy of consideration in the United States, and may lead to a new industry. In 1850, Moritz Schmerler conceived the idea of making small fancy articles of the shells themselves, and succeeded so well that the German Government allowed him to take from the Royal beds the shells needed for his manufacturing business. Large numbers of pearl shell pocket-books and hand-satchels have been made since then. The almost faultless white and reddish tinted "rose-pearl mussels" are specially prized for this purpose, as the material may be cut so thin that a photograph

pasted on the inside can be seen through the shell, conveying the appearance of being produced on the shell itself. Other manufacturers engaged in the business, as soon as its success became apparent, and many hundred thousands of pearl mussels are now annually used at Aldorf, where the business is chiefly carried on. The principal sources of supply are brooks in Bavaria and Bohemia that are owned by private persons. Why not Tennessee, Wisconsin and Texas?

Pearls are usually found either by farmers, who devote their spare time to this industry, and, if no result is obtained, suffer no loss, or by persons in country villages who are without regular occupations, but are ever seeking means for rapid increase of fortune. Many shells that do not contain pearls are destroyed. In order to obviate this

FIG. 10. METHOD OF OPENING MUSSELS IN SAXONY IN ORDER TO SEE IF THEY CONTAIN PEARLS.

wholesale destruction, it would be well to give the industries a legal protection, making it punishable by fine to kill a Unio, and requiring all pearl-fishers to use instruments like those that are employed in Saxony and Bavaria. (See illustration, "Gems and Precious Stones of North America," New York, 1893; Figs. 10 and 11, page 232.)

In the former country a thin flat iron tool with a bent

end is inserted into the shell. The handle is then turned 90 degrees and the shell is opened without injury to the animal. Another instrument is a pair of pliers with sharp-pointed jaws, and a screw between the arms, which isturned by the hand until the valves of the shell are sufficiently distended to see whether it contains a pearl. If it does not, the animal is returned to its former haunts, perhaps to propagate more valuable progeny. In gathering the shells, only those that are full-grown, old and distorted by disease should be taken, and these only opened and not destroyed, so that the fisheries may be preserved; and the shells should be opened as soon as taken from the water, and not allowed to open by decay, for this discolors the pearls; and particularly, they must never be opened by boiling water, as this dims the lustre and lessens the value of the pearl. Many lakes and rivers, among them the Olentang at Delaware, Ohio, and a number of streams near Columbus, have been completely raked and scraped, often in a reckless manner, and consequently with very little result. The general method of collecting shells was for a number of boys and men to wade into the mill-race or into the river to their necks, feeling for the sharp ends of the Unios, which always project. When one was discovered in this manner, the finder would either dive after it or lift it with his feet. It was the custom at that time to open the shells in the water, and once during the process a pearl, the size of a pigeon's egg, is said to have been dropped into the water and never recovered.

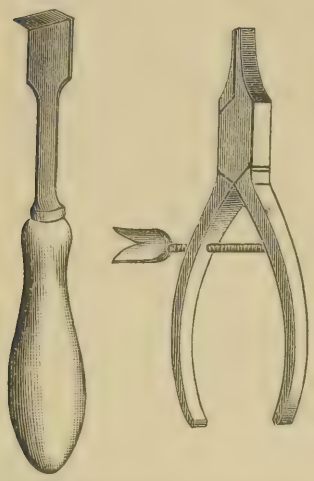

FIG. 11. INSTRUMENT USED IN SAXONY TO OPEN MUSSELS WITHOUT KILLING THEM.

This wholesale destruction, together with the depredations of hogs, which have exterminated whole shoals of Unios when the water in the brooks was low, and the substances introduced into the water by manufacturing industries, besides sewerage and refuse from factories, are rapidly causing the disappearance of animal life from many of our water courses.

It is probable that the existence of carbonate of lime in excess where mussels abound, influences the secretion that causes the growth of the pearls. In lime-stone regions, if the waters are polluted by products of decomposition that are acid, these unite with the lime and form other compounds, which are either precipitated or carried away with the impurities of the water. There can be no doubt that this cause would tend to decrease the amount of lime which the shell would receive, thus not only retarding the growth of the pearls, but often eventually leading to the extermination of the Unios themselves. At nearly all the marine pearl-fisheries, coral-banks abound; branches of coral frequently forming on the shells themselves, sometimes three or four species on a single shell; and it may be that these have more or less influence on the development of the pearl in the shell. In Vermont, New Jersey and Ohio, where pearls were formerly found, a fine one is now rarely obtained.

A unique method of collecting Unios is that practiced by the lumbermen, who, while sailing down the Canadian rivers on their rafts, collect Unios for food, by fastening bushes to the rear of the raft, so that when they pass through the mussel shoals, where the rivers are shallow, the bushes touch, the Unios close on the leaves and thin branches, holding them securely; and at intervals the bushes are taken out and the Unios removed.

In regard to these pearl excitements which appear from time to time, and as to where best to search for pearls, it may be well to state that it is advisable to search every

creek and river where limestone is the country rock, since in nearly all instances the Unios secrete pearls when this favorable condition exists.

The great quantities of Unio pearls that existed in prehistoric times is evidenced by the Little Miami Valley, explored by Prof. Frederick W. Putnam and Dr. Charles L. Metz, and more recently by Warren K. Moorehead, who carried on operations for Prof. Putnam. The former procured over 60,000 pearls, nearly two bushels, drilled, undoubtedly of Unio origin, all of them, however, decayed or much altered, and of no commercial value. In 1884, the former scientists examined the Marriott Mound, where they found nearly 100 Unio shells, and among other objects of special interest six canine teeth of bears, that were perforated by a lateral hole near the edge at the point of the greatest curvature of the root, and by passing a cord through this, the tooth could be fastened to any object or worn as an ornament. Two of these teeth had a hole bored through near the end of the root on the side opposite the lateral perforation, and the whole countersunk in order to receive a large spherical pearl, about $\frac{3}{8}$ inch in diameter. When the teeth were found, the pearls were in place, although chalky from decay. Upward of 250 pearl beads were found, concerning which they say: "The pearl beads found in the several positions mentioned are natural pearl, probably obtained from the several species of Unios in the Ohio River. In size they vary from $_{10}$ inch to $\frac{1}{2}$ inch in diameter, and many are spherical. They are neatly drilled, and the larger from opposite sides. These pearls are now chalky and crumble on handling, but when fresh they would have formed brilliant necklaces and pendants." The find of Mr. Moorehead is exhibited in the Anthropology Building of the World's Fair, and belongs to the collection that is to be made the permanent one of the city of Chicago, to be shown ultimately in the Fine Arts Building, Jackson Park.

Among marine shells of the United States, the common clam (Venus mercenaria) secretes pure white pearls, scarcely distinguishable from ivory buttons, as well as others faintly tinted with a purplish blue, passing at times to a reddish purple, and a purplish black. The white pearls are worthless, the tinted ones are of little value, but those of a darker color are often from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in diameter, and the finest ones bring from $20 to $100. The supply is limited, and there is very little demand, for unless the color is exceptionally good they possess little beauty, lacking the lustre peculiar to other pearls; still, when mounted with diamonds, the appearance of darker ones is much improved.

The making of wampum from these shells and from the conch has been carried on by a family of Campbells at Pascack, New Jersey, from 1770 to the present time. The last four brothers were over 80 years old in 1889. See "Gems and Precious Stones of North America," pages 233 and 234.

The common oysters (Ostrea borealis and Ostrea virginica) occasionally secrete one or more pearly bodies, always dead-white in color. The reflections produced by their fibrous, radiated structure are similar to those observed in the common conch. The "skin" of these pearls is never smooth or lustrous, and consequently they have no value.

Conch pearls—the concretions found in the common conch of the West Indies (Strombus gigas)—are not nacreous, and therefore cannot be considered true pearls. They are usually a little elongated or oblong in form, rarely round, and most of them are very beautiful, owing to the reflections produced by their fibrous, stellated structure, causing the light to play over the surface, but giving a different effect from the cat's eye, or that of satin-spar. They are almost pink in color, and the fine ones are wonderfully lustrous.

The abalone (haliotis, or ear-shell), the principal species

of which are Haliotis splendens and Haliotis rufescens (called ormer in the Channel Island, fuh-yu in China, awabi in Japan, and abalone in California), also secretes pearls. The nacreous portion of the shell itself is used for ornamental purposes, such as buttons, etc., and surface ornamentation in lacquer work, papier-mache, etc. The mollusk itself, called "mutton-fish" by the New Zealanders, has long been known to the Indians of the Pacific coast as a valuable article of food, and it is much sought after by the Japanese and Chinese for the same purpose. The former take only the very smallest fish, and eat them when freshly caught, with cayenne pepper and vinegar, while the Chinese seek out the largest, and eat them only after they have been dried.

The trade in this dried meat is considerable. In 1866 there were exported from San Francisco by steamer 1,697 sacks, valued at $14,440, and in 1867 the exports had risen to 3,713 sacks, valued at $33,090. At present there are exported upward of 200 tons a year, which at $175 a ton would amount to $35,000. At San Diego, Cal., the dried meat is quoted at $110 a ton. The shells vary from almost microscopic size to eight or ten inches in diameter. Before they were found to have marketable value, they were thrown away. One heap a little south of San Diego, containing over a hundred tons of shells, from exposure to the rain and the sun, was converted into lime on the outside; but this was broken into and many fine shells were found. The Pueblo, Zuni and Navajo Indians, and all the Indians of the Pacific coast as far north as Alaska, have made the abalone shell into charms and have used it for ornamentation with remarkable taste, for ages. It was used with great success by Messrs. Tiffany & Co., as an applied decoration on silver objects, and was exhibited at the World's Fair held in Paris during 1889.

The collector of customs at San Francisco furnishes the information that for the fiscal year 1887–1888, the export of

abalone shell amounted to $185,414, which, together with $35,000, the value of the dried meat annually exported, makes this quite an important industry. These shells secrete very curious pearly masses, sometimes of fine lustre and choice enough to deserve a place among pearls. A pearl measuring two inches in length and from ¼ to ½ inch in width has been found. A necklace made in California from the finest specimens was valued at $2,000. A pearl over half an inch long and of good color cost $30, and was used as the body of a jeweled fly. The abalone pearls from the coasts of Korea and Japan are often very beautiful. In a lot of about one hundred shells only five were found bearing pearls, two with three pearls each, two with two pearls each, and one with a single pearl.

Capt. J. W. Collins—I have been very much interested in the valuable paper read by Mr. Kunz. It is timely and important, and is worthy of careful consideration by those of our citizens living in the interior who are interested in the collection of fresh water-pearls. As most of you know, many pearls have been gathered in the Central States, and especially in some of the States bordering the Great Lakes. I fear, however, that lack of information on the part of those who have been engaged in this effort has resulted in the practical extermination of pearl-bearing shells in certain regions, since I believe it to be true that, practically in all cases, the animals have been killed in order to ascertain whether they contained pearls or not. If the people who sought the pearls had known that it was perfectly feasible to obtain them without injuring the animals, by the use of a simple tool, such as has been mentioned by Mr. Kunz, and had they realized the importance to them in future years of conserving the supply of these wealth-producing bivalves, there is reason to believe that quite a large collection of pearls could have been made at intervals of every few years. Now, however, because of a lack of this knowledge, the pearl producing shells in the sections

referred to, are practically annihilated, and it will probably be many years before it is possible to reap another harvest. I know of nothing which bears upon the fisheries of our interior States, which could be of more service to those interested in this industry, than the widespread publication of the paper that Mr. Kunz has favored us with. Whatever tends to improve the knowledge of our fishermen, and enables them to conserve the supply of those animals which constitute objects of fishery, while seeking aquatic wealth, adds materially to the welfare and prosperity of our country and the comfort of our people.

Among the fishery subjects that demand the intelligent consideration of State legislators, none, perhaps, should receive more prompt attention than this matter of gathering pearls. No State can afford to neglect legislation on a subject so important. Unless there is legislative restriction, we may look for a repetition of what has been done in the States referred to by Mr. Kunz.

THE SUNAPEE SAIBLING: A FOURTH NEW ENGLAND VARIETY OF SALVELINUS.

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The sudden and unaccountable appearance, in large numbers, of a valuable food and game fish in any of our inland waters would be hailed as a most important event both in the angling and the ichthyological world. Assume that fish to be a prolific and rapidly growing salmonoid, surpassing all congeners in symmetry and brilliancy of coloration, equalling the most delicate in table merits, and excelled in game qualities by the land-locked salmon alone—and you may readily comprehend the enthusiasm which, some seven or eight years ago, greeted the discov-

ery of a New Hampshire charr characterized by such a synthesis of traits.

Until the year 1885 but three species of trout, or, more properly, *charr* (a Gaelic word meaning *red*, or *blood-colored*), were recognized as native to New England, viz. :

I. The *Salvelinus fontinalis*, or common brook trout.

II. The *Salvelinus namaycush*, the longe, togue, lake, or Mackinaw trout.

III. The *Salvelinus stagnalis* of Fabricius; *oquassa* of Girard and Gunther, the diminutive blue-back of the Rangeley Lakes of western Maine—the last closely allied to species widely spread through Arctic America, as well as to the European saibling.

From this classification is omitted *Salmo agassizii*, of Lake Monadnock, N. H., now recognized as a variety of brook trout; and the *Salmo hucho*, or *hunchen* trout, mentioned by Dr. Smith in his "Natural History of the Fishes of Massachusetts," 1833, and therein claimed to be related to the true *hucho* of the Danube. Its forked tail, dusky hue and reddish spots, coupled with the statement that it was brought to market in a frozen condition from lakes in New Hampshire and Maine, make it probable that the Massachusetts *hucho* was merely a variety of *namaycush*.

Even Prof. Jordan, in an article on the Salmon Family, published in "Science Sketches" as late as 1888, is silent as regards a fourth New England species; although Prof. Garman, of the Museum of Comparative Zoology at Cambridge, in his paper on the American Salmon and Trout (1885), calls attention, under the head of *Salmo fontinalis*, to a form, Fig. 16, of which he says: "A knowledge of the younger stages of this fish from the same locality may lead to a separation of the form." Subsequent research *has* led to such a separation, and ichthyologists now admit the presence of a fourth variety of *Salvelinus* in New England —the *alpinus aureolus*, or golden-hued Alpine charr,

whose life history and general characteristics it is the purpose of this paper to present.

As far as is known, the first specimens of this new fish to be distinguished from the well-known forms were taken in Sunapee Lake, Merrimac Co., New Hampshire, during the summer of 1881, by Lieut. Ransom F Sargent and Mr. Alonzo J. Cheney, respectively of New London and Wilmot, experienced anglers, who immediately recognized in the three individuals captured by them specimens of a salmonoid distinct from the *namaycush* and from the brook trout of the region. The fish taken weighed from two to three pounds each, and were known by the name of "St. John's River trout," because they were believed to be descendants of fry planted in the lake in 1867 by the first Fish Commissioners of the State, and supposed by the resident population to have come from the St. John River, N. B. The conspicuous development of the under jaw in the males led to the local names of "hawkbill" and "hookbill;" the silvery sides of the fish in summer gave rise to that of "white trout." In the two following years, 1882 and 1883, a sufficient number of the deep-swimming stranger was taken to excite comment and conjecture on the part of outsiders who had heard of its presence in Sunapee Lake; and in 1884, Col. Elliott B. Hodge, of Holderness, the New Hampshire Fish and Game Commissioner, finding confirmation in the reports that reached him for a view he seems long to have privately held, ventured the opinion that many Canadian and northern New England lakes contained a large charr, whose habit of retiring to the deepest and coldest waters throughout the summer, and of approaching the surface for a few days only at the end of October, explained a general ignorance concerning its very existence. Col. Hodge's theory received apparent substantiation from his accidental discovery in October, 1885, of vast numbers of a mysterious charr spawning on a mid-lake, rocky shoal at Sunapee. He wrote at the

time: "I can show you an acre of these trout, hundreds of which will weigh from three to eight pounds each. I could never have believed such a sight possible in New Hampshire. The new fish differs from the brook trout in many ways. The females have a brownish back and lemon-colored sides; the males, a bluish black back and golden-orange sides. The fins are much larger than in the brook trout, and there is an entire absence of the mottling characteristic of the latter fish."

Thus Col. Hodge recognized in this graceful, high-colored charr a new variety, and he lost no time in inviting the attention of scientists to the New Hampshire beauty. Specimens were forwarded to the Museum of Comparative Zoology at Cambridge, Mass., and to Dr. Tarleton H. Bean, Curator of the Department of Fishes, National Museum, only to be pronounced at both centres varieties of brook trout. Col. Hodge resented this classification, and sent Dr. Bean other large specimens of the new fish, together with several Sunapee brook trout, urging a more minute examination. Dr. Bean compared the two forms with special care, changed his opinion, frankly admitted that Col. Hodge was right, and pronounced the Sunapee trout "a *Salvelinus* of the *oquassa* type, but of so enormous a size that at first he did not suspect its relation to that species." The late Prof. Baird inclined to the opinion that it might be a representative of a highly variable Arctic charr found in the Dominion of Canada and Greenland, viz.: the *Salvelinus arcturus*. (Victoria Lake and Floeberg Beach in extreme northern part of Arctic America—allied to *stagnalis*.)

A controversy at once arose regarding the origin of this unique trout. Whatever its species, it was a newcomer in the opinion of some; in that of others, a native—the oldest of our charrs, representing the ancestral type, and now almost extinct. Those who took the first view were chiefly

residents of the immediate region. Such unhesitatingly declared that they had never met with the new fish prior to 1883 or 1884. They regarded the *oquassa* (or "Quashy," as it began to be called) either as a descendant of some of the salmonoids introduced into Sunapee in 1867 and succeeding years by the Fish Commissioners, or as a cross between one of these forms and the native brook trout. In no other way could they account for its sudden appearance in large and steadily increasing numbers.

A theory of descent from blue-backs imported from Maine in 1879 by Commissioners Webber and Powers as a food supply for the larger *Salmonidæ*, was soon set aside on the ground that the little trout of the Rangeleys rarely exceeds ¼ pound in weight, and could not possibly, even if supplied with an abundance of appropriate food and exposed to the tonic effects of a favorable change of waters, ever attain the aldermanic proportions of the Sunapee charr. Moreover, Dr. Bean, in a scholarly paper published in the *American Angler* and the *Forest and Stream*, February, 1888, called attention to six essential points of difference between the Sunapee trout and the blue-back, thus effectually disposing of the argument.

The theory of natural hybridism found few supporters among ichthyologists, and no introduction of charr other than the Rangeley *Salvelinus fontinalis* and *Salvelinus oquassa* could be proved, as none had been officially reported. From the first, Col. Hodge, believing in the existence of a similar charr in the Province of Quebec, championed the theory of aboriginality, ingeniously combating every objection made to it:

I. That so conspicuous a food fish could not for 100 years have escaped the notice of anglers, poachers and scientists alike—by showing how the habits of the white trout protected it from observation and persecution, it being rarely seen except late in October on mid-lake reefs, that is, *at a time* of year when angling was out of season,

and *in localities* dangerous or impossible of access in the old-style, unseaworthy flat-bottoms during the autumnal windstorms. The secluded habits of the European charrs explain in like manner the obscurity which has so long involved the life history of those fishes. Col. Hodge further claims that ordinary fishermen knew no difference between the white and the brook trout, a thing not to be wondered at when such authorities as Garman and Bean failed at first to separate the forms.

II. The more serious objection that no cause can be shown why the white trout, if a native, should *suddenly* increase in the lake, so as to attract the attention of hundreds of observers, and be taken literally by the ton, Commissioner Hodge meets with the following clever theory: Before the introduction of black bass about 25 years ago, yellow perch swarmed in the lake, and there being then no smelt food, subsisted largely on the eggs and fry of the lake-spawning charr. At the spring hatching time, these perch held carnival among the helpless alevins, almost effecting, by their periodic ravages, the extermination of the white trout. But as the black bass increased in number, they fell upon the perch in turn, until the lake was virtually rid of this voracious pest. Thus the trout, which had been reduced to the verge of annihilation, had a chance to increase. The black bass did not interfere with it for two reasons:

I. Both bass and trout have an abundance of easily caught and tasteful food in the land-locked smelts, which have multiplied since their introduction, until now they literally school in millions.

II. Bass and trout are not found in the same sections of water at the same time, the trout keeping in a temperature of 42° to 45° (on the surface in May, 60 ft. below in July and August); the bass preferring 65° to 70° in summer, and hibernating in winter and during the spring hatching time of the trout. Thus freed from persecution, the saib-

ling has increased, until it is now present in myriads. This is the most ingenious of all the explanations that have been advanced. It is based on facts throughout, and is difficult of overthrow, especially when coupled with a theory of the writer's—that after the introduction of smelts, about 20 years ago, the saibling, if native, learned so far to change their habits as to rise from the depths and follow this food fish to the shores during May and June, thus increasing the chances of discovery. Wherever the smelt schools, there the saibling will be found. An axiom of the Sunapee fisherman is: "Hold the smelts and you will hold the trout," so the smelts are baited in certain localities during the fishing season.

This theory of Col. Hodge encounters but a single objection, viz., if the perch and saibling have been fellows in the Sunapee basin since its excavation during the Glacial Epoch, why was not the process of extermination completed centuries ago? It *must* have been in the case of other lakes on the same primeval watershed, unless we are prepared to admit that an anadromous fish became landlocked in one inland lake alone, while avoiding other bodies of water much more accessible and equally compatible Geology proves that Sunapee once discharged its waters through Newbury summit, and thus was tributary to the Merrimac. Hence, it is fair to assume that when these trout migrated, following like man and the larger mammalia, but through watery channels, the retreating ice-fields and glaciers, they swarmed into many lake-basins, where they became extinct before the advent of the white man. Were perch the instruments of extermination? If so, why did they not put in as thorough work at Sunapee?

It is but right to state at this point that the history of the charr in some European lakes is the history of a fish that has disappeared within the memory of man. This is notably the case at Loch Leven, once the home of a charr

that rivalled the magnificent fish of Windermere. The trout (*fario*) seems the fitter to survive.

While the discussion just outlined was progressing, charr identical with the Sunapee Lake form were sent from Dan Hole Pond, Carroll Co., N. H., and from Flood's Pond, in the town of Otis, 16 miles from Ellsworth, Maine, to Prof. Garman and Dr. Bean. The water of both these lakes is deep, clear and cold, as in the case of Sunapee. Dan Hole Pond, at the headwaters of the Ossipee River, is tributary to the Saco. Flood's Pond connects with the Union River, which enters Blue Hill Bay near Mt. Desert. Thus the new *Salvelinus* is represented in three distinct drainage basins in New England.

In company with Col. Hodge I visited Dan Hole Pond in the summer of 1889, but failed to secure a specimen of the saibling. In the fall of 1890, however, several specimens were sent from the pond to Cambridge and to Washington, where they were pronounced identical with the Sunapee form. Old residents declared them identical also with trout which had for fifty years been speared on the same spawning bed. The present representative from Ossipee informs me, through Commissioner Hodge, that he has seen many individuals of this species weighing 10 and 12 pounds—all this years before a German saibling egg was imported.

I am indebted to Dr. Walter M. Haines, of Ellsworth, Maine, for the following facts regarding Flood's Pond: The pond is three miles long and ¾ mile wide. It is surrounded by high, well-wooded land, and is 100 feet deep, the bottom being pure white sand or gravel. There are the usual inlets and spring-holes. The outlet is a stream of considerable size, and has been dammed in many places for the last forty years. The Flood's Pond saibling, declared by Prof. Garman to correspond exactly with the Sunapee fish, is known in the neighborhood as the "silver," or "white trout," to distinguish it from "the square-

tail," or brook trout, and "the togue," or lake trout. It attains a weight of five or six pounds. Two hundred pounds have been taken by a single angler in a day, but it is never caught except in one particular locality. It spawns in the lake on a fine gravel beach, in three feet of water, and does not enter the inlets. Nothing but smelts are ever found in its stomach. Flood's Pond contains neither perch nor bass.

Since, then, by reason of dams on the outlets, no fishes of marine ancestry could, within the last fifty years, have gained access either to Dan Hole or Flood's Pond without artificial help—since land-locked salmon only have been planted in these ponds, and that quite recently—and since there seems to be trustworthy evidence of the existence of this so-called silver trout in each body of water for at least half a century—it is fair to conclude that the *Salvelinus alpinus aureolus* is a native of two Maine drainage basins, and therefore is aboriginal to New England, an American representative of the European saibling, red charr, or *ombre chevalier*.

But this does not prove its aboriginality to Sunapee Lake, N. H., although, all circumstances considered, it renders such aboriginality highly probable, inasmuch as no data exist to establish a plant of this variety at any time in Sunapee Lake, and no German saibling eggs were brought to New Hampshire before January, 1881. The fact that the fry from the eggs sent to Plymouth in that year were placed in Newfound Lake, a body of water apparently in every way adapted to the nature of the saibling, but have never been heard from, is further significant here. It may prove that the foreign fish cannot find the necessary conditions in the New Hampshire lakes. The failure of the farmers at Sunapee to distinguish between the large brook trout and the saibling (if the latter fish was a native) is in contrast with the positive knowledge of a difference at Dan Hole and Flood's Ponds. Its explana-

tion may be sought in the habits of the Sunapee saibling, as already described, or in the ignorance of the few who in old times may ever have seen it, and who cared for nothing beyond the fact that it was good to eat.

Ford's Pond in Warren, and Silver Lake in Madison, are associated with traditions of the fall spearing on their spawning beds of large, high-colored trout, which are believed, from reports as to their habits and appearance, to have belonged to this same species. These two ponds, then, may represent a traditional habitat. The waters of Silver Lake find their way into the Saco; I was unable to learn whether Ford's Pond discharges into the Connecticut, or through Baker's River into the Merrimac.

In April, 1893, a four-pound specimen of a square-tailed trout was sent to me from Swan Lake, near Belfast, Maine. It was remarkably like the *aureolus* of Sunapee, from which fish it differed in having a large mouth, well-armed with teeth, and a mottled dorsal fin. The pectoral, ventral and anal fins were orange in hue, but smaller than in the case of the Sunapee species. Prof. Garman inclined to the opinion that the Swan Lake fish (judging from this one specimen) is a form of *Salvelinus fontinalis*. Were hybridism possible, I should suspect a cross between the brook trout and the American saibling. At first sight one would certainly pronounce the Swan Lake fish an *aureolus*.

Swan Lake is but a short distance from Flood's Pond, the valley of the Penobscot lying between the two.

I am under obligations to Dr. Bashford Dean, of the Department of Biology, Columbia College, for material assistance in determining the following anatomical description of the Sunapee saibling:

Two specimens of one pound and three pounds respectively were carefully examined.

FIN RAY FORMULA.

	1-LB. SPECIMEN.	3-LB. SPECIMEN.
Pectoral	14	13
Dorsal	13	14
Ventral	11	10
Anal	13	12
Caudal	26	28

(including rudimentaries.)

SQUAMATION.

	1-LB. SPECIMEN.	3-LB. SPECIMEN.
Lateral	211 to 212	226
To lateral line	38	41
To vent	62	63

DENTITION.

(Feebly developed as in the Irish charrs.)

	1-LB. SPECIMEN.	3-LB. SPECIMEN.
Maxillary (superior and inf.)	13 and 14	16
Pre or *Intermaxillary*	4 and 5	4 and 3
Vomerine (very small)	6 in number	2 and larger
Palatines (right and left)	12 and 13	13 and 13
Glossal two rows of	4	5 and 4.

GILL RAKERS.

18 in front row. 18 in second row.

Slender and longer than in the brook trout.

PYLORIC CŒCA.

1-LB. SPECIMEN, 45 (small and short) 3-LB. SPECIMEN, 52

BRANCHIOSTEGALS.

9 on each side.

In young specimens, the gill cover overlaps the root of the pectoral; not in adults. There are spots on the dorsal fin, and attention should be called to a post-ventral dermal appendage.

Such differences in individuals from the same locality would seem to impair the value of anatomical peculiarities as diagnostic marks. In fact, in a most able paper on the Saiblings, published in the *American Angler*, February 7, 1891, and *Shooting and Fishing*, February 12, Prof. Garman states that in foreign specimens examined by him the dentition differs, corresponding more or less nearly with that of the New Hampshire fish—that differences of age imply radical differences in teeth, fins, stomach, and especially gill-rakers—which latter Prof. Garman believes

to be "most important in function early in life and to deteriorate with change to coarser food." The deterioration consists in a distortion not alike in any two individuals; "the rakers curve and twist in every direction like a lot of writhing worms suddenly become rigid." In old specimens they lose their points and grow club-shaped. As to the number of gill-rakers, in saibling where Dr. Bean found 10 and Prof. Jordan 14 to 15, Prof. Garman counted 14 to 18. And in the New Hampshire charr, where the first found 14, and the second 11 to 12, Prof. Garman counted 13 to 16. In our specimens, 18 were counted in each row.

The external characteristics of the Sunapee fish, however, distinguish it conspicuously from the three other charrs of New England. Its graceful build, small and delicately shaped head, small mouth, excessively developed fins, more or less markedly emarginate caudal, spots without the blue areola, and unmottled back, at once separate it from the brook trout, and link it as closely as its structural peculiarities with Austrian, British and Swiss congeners. The nuptial coloration is gorgeous beyond example among our indigenous *Salmonidæ*. Throughout the spring and summer the back is dark sea-green, blending on the sides into a flashing silver, which in turn deepens below into a rich cream. But as the October pairing time approaches, the fish is metamorphosed into a creature of indescribable brilliancy. The deep purplish blue of the back and shoulders now seems to dissolve into a dreamy sheen of amethyst, through which the inconspicuous pale lemon spots of midsummer flame out in points of yellow or vermilion fire; while below the lateral line all is dazzling orange. The fins catch the hue of the adjacent parts, and pectoral, ventral, anal and lower lobe of caudal, are ribboned with a broad white margin. As in the case of the Windermere charr, these white margins of the fins are very conspicuous in specimens seen swimming in the

water. There are great differences in intensity of general coloration, and the females are not usually as gaudily tinted as the males. The intermediate types and different depths of hue observable in an autumn school recall the public promenade in a West Indian city, where all shades of transition are found, from pure white to tawny black. Those who have seen the flashing hordes on the spawning beds, in all their glory of color and majesty of action, pronounce it a spectacle never to be forgotten.

Sunapee saibling kept in confinement entirely lose the sexual instinct, and with it the wedding garment. So sensitive are the females that their removal from the spawning beds to the State Hatchery on the opposite shore of the lake, only one mile distant, seriously interferes with the maturing process, so that it is almost impossible to secure eggs, the fish having frequently to be returned to the water several times during the operation. Hence, as far as possible, ripe specimens are selected on the natural spawning beds, and there stripped rapidly and returned to the lake. Instances are not exceptional in which females refuse to part with their eggs and carry them over to the next season. This tallies with Mr. Cholmondeley-Pennell's suggestion that some of the Windermere charr spawn in alternate years.

Although a vigorous fighter, the white trout is very easily injured, the prick of the hook often being followed by fatal consequences, especially in young specimens. Hundreds are thus unavoidably killed every summer. In this respect the Sunapee charr is very unlike the blueback of Maine, of which Commissioner Stanley said: "They are a hardy fish, and nearly as tenacious of life as the eel or bullhead. I have frequently seen them alive in the morning after lying all night on the shore."

One other phase of *aureolus* life is a marked tendency to deformity. Remarkable differences in shape, as well as coloration, are normal to the quadroons and octoroons of

the Sunapee spawning beds; but these differences are sometimes carried to the verge of distortion or even monstrosity. Humped backs are not infrequent; but the most repulsive and at the same time most common malformation is the shrinking of the mature fish into an eel-like shape, with abdominal respiration and an intensely reproachful human look in the cavernous eyes, which fix your gaze with a mysterious intelligence. The death scene of such a fish will haunt one for days, tempting him to speculation in the field of metempsychosis.

Prof. Garman has proclaimed his belief in the identity of the Sunapee, Dan Hole and Flood's Pond charrs with the European saibling, and that "the affinities of these forms are closer to that saibling by way of an Atlantic steamer than by way of Greenland and Iceland."

Prof. Jordan has said "the American charr is probably not a distinct species, but native to the waters where it is now found, and not an importation from Europe." "Should it appear," he continues, "that the saibling in that part of Germany from which specimens have been brought to America, have gill-rakers like those of the Sunapee trout, this opinion would be reconsidered." Prof. Garman has disposed of the gill-raker argument, but as far as I know Prof. Jordan has not further expressed himself in regard to the Sunapee form; although in a recent article on the salmon and trout of the Pacific coast he states that "in the lakes of Greenland and the eastern part of British America the European charr is as abundant as it is in Europe—a fact which has only lately been made manifest."

Mr. J. G. A. Creighton, of Ottawa, Canada, writes under date of February 16, 1893: "From the height and character of Sunapee Lake, it is not at all improbable that an Arctic variety may have survived there which has perished, or been transformed, elsewhere south of 55° or 60° N. Lat. Arctic species must have been common to all our waters in the Glacial period."

The opinion of Prof. Jordan and Mr. Creighton regarding the survival of Arctic charr in southern Canada and northeastern United States have received confirmation recently by the discovery, in a lake of Huntertown, Province of Quebec, of a symmetrical, unmottled, unspotted charr, with markedly forked tail, small fins, diminutive mouth, weak dentition, large liquid eye, pink flush and brilliant iridescence below the median line. I can say of the specimen examined by me that it was *neither a blue-back nor a Sunapee saibling.*

Prof. Garman writes me under date of November 17, 1892, that "no good evidence has been advanced of the existence of this species *on this continent* previous to 1884." It is a matter of record, however, that 60,000 German saibling eggs, the gift of the Deutsche Fischerei Verein, were sent to New Hampshire in January, 1881. It is further to be taken into consideration that the writer of this paper had in his possession, at Sunapee Lake, in the summer of 1882, a four-pound specimen of the saibling in question—which could not have developed from fry hatched the preceding year! No saibling have ever been sent to Maine by the United States Fish Commission; and, as has been shown, it is impossible that the fish in Flood's Pond can be descendants of the New Hampshire charr. The theory that there was nothing to prevent the *Salvelinus alpinus* of Sunapee Lake in recent years from descending the Connecticut River to Long Island Sound, and thence making its way into streams and connecting lakes from the shores of Connecticut to those of Greenland, may be disposed of in a single word—*Dams.*

The Sunapee charr is undoubtedly a representative of the European form; but reasons have been given why it is believed to be a native of this continent. It differs no more extensively from the several European varieties than they do among themselves. Von dem Borne, Profs. Benecke and Dalmer, Wittmack, of Berlin—all speak of

important differences in form, size and color, according to age, sex, season and habitat. All authorities allude to the *solid* sea-green or dark blue of the back, the yellowish sides and the red or orange belly. Benecke and Dalmer refer picturesquely to the half-moon tail. As to spots, there is endless variety. Some forms have none; some, large spots; others, small—yellow, orange and red—and singularly, in certain species, each spot is surrounded by a white ring or halo. The fins take their color from the back and sides, and have the broad white band. The foreign saibling is gregarious, like the Sunapee form; lives similarly on crustaceans, worms and fish food, and seeks the deepest and coldest waters. The greater the altitude, the more intense the coloration and the smaller the fish. In Lake Zug the saibling run eight or nine to the pound; in Lake Geneva they are said to attain a weight of over 20 pounds. The flesh is white or red, which, however, makes no difference in the flavor. The foreign saibling is taken in nets, or with hook and line; it is eaten fresh or smoked.

Col. Hodge has attempted to prove a dissimilarity between the German saibling and the Sunapee charr by crossing each with our common brook trout, and noticing differences in the markings of the resulting fry. He writes me that the eggs of the cross between the German saibling and our brook trout are larger than those of the cross between the Sunapee *aureolus* and the brook trout, and that there are conspicuous differences in the fry of the two hybrids, both of which are fertile. Crossing our brook trout with other forms of the foreign saibling would certainly give different results again; so the experiments of Col. Hodge cannot be regarded as conclusive beyond establishing the fact *that the aureolus of Sunapee is in no way connected with the particular form of German saibling sent to New Hampshire in* 1881; but this is a most important fact in the induction of its aboriginality to New

England. Col. Hodge further states another supposed difference: "The *aureolus* does not seek the streams to spawn; the saibling does." But the saibling does not always spawn in streams; the rule is the other way. At Windermere, the charr spawn both on the rocky bed of the Brathay and in the lake. Schroeder, in his "Katechismus der Kuenstlichen Fischzucht," expressly states that the saibling in October and November ascends from the depths in which it usually lives, and spawns off sandy shores in the lakes. Profs. Benecke and Dalmer describe great schools of fish spawning in October or later, even as late as January and March, on sand or gravel near the shores. The Sunapee fish, then, simply follows the practice of its European relatives.

Finally, there can be no doubt as to the economic value of this new fish. It is one of the most prolific of our salmonoids, the female averaging 1,200 eggs to the pound, or 200 more than the brook trout. It is also a singularly rapid grower where smelt food abounds. The extreme weight known to have been attained in Sunapee is about eight pounds, although accounts exist of much larger fish in this water, and of specimens from Dan Hole and Flood's Ponds weighing from 15 to 20 pounds.

The Sunapee saibling takes live bait readily, and affords the angler superb sport if the tackle be light. With a seven-ounce rod and 200 feet of line, the killing of a five-pounder from a sail-boat running across the wind, implies a delightful excitement that, to be appreciated, must be experienced. Three tons of this fish have been taken with hook and line in a single season at Sunapee. The flesh is of a light salmon color, and when in its perfection excels in delicacy that of all other *Salmonidæ*.

We must confidently recommend this charr to the attention of State Commissioners interested in placing a valuable and easily propagated food fish within reach of the people. It is *facile princeps*, from its rush at the cast

smelt to the finish at the breakfast table. Those who best know it most enthusiastically indorse, with a slight amendment, Prof. Jordan's apothegm: "Nothing higher can be said of a salmonoid than that it is a [Sunapee] charr."

ON THE HANDLING OF ADHESIVE EGGS.

BY PROF. JACOB REIGHARD.

The title of the paper which I will read at this time is upon the handling of adhesive eggs. A part of what I have to say has already been printed in the Tenth Annual Report of the Michigan Fish Commission, with some additions.

Those who have had experience in taking the eggs of the wall-eyed pike or pike-perch are familiar with the difficulties which arise from their adhesiveness. For the first hour or two after they are placed in the water the eggs adhere to one another and to the vessel which contains them. The adhesiveness is due to the action of the water on the outer egg membrane, which behaves in this respect like other mucous bodies.

It has been thought necessary to resort to constant stirring or shaking in order to keep the eggs apart. Not only is much time wasted in this stirring or shaking, but large numbers of the eggs are injured. Even after the eggs have been placed in the hatching jars, dead ones are attacked by fungus, which causes them to adhere to one another and to the living eggs, so that they must frequently be taken from the jars and passed through sieves in order to separate them.

These eggs are usually delicate, and the result of this rough handling to which they are subjected, owing to mechanical injuries and the resulting attacks of fungus, is that about 70% of them are usually killed. It seemed, therefore, desirable to find some method of dealing with

these eggs which should prevent their adhering to one another, without its being necessary to resort to stirring or other mechanical agitation.

One method that has been pursued is to allow the eggs to lie in the water in which they are fertilized. Such water is milky from the large number of spermatozoa which it contains, and is also quite strongly alkaline.

Eggs left in the water do not adhere, and after having lain in the milted water for two hours they may be transferred to fresh water, and will usually not then adhere. This would then seem to be a solution of the difficulty, but some experiments which I have made, and which are published in the Tenth Report of the Michigan Fish Commission, show that when eggs are treated in this way many of them fail to absorb water and remain of smaller size and softer than normal eggs. Such eggs do not afterward develop. The method is, therefore, not practicable.

It seemed that the result sought might be accomplished in any one of three other ways.

1. Some substance might be dissolved in the water, which, without injuring the egg or spermatozoon, might still so act on the external egg membrane as to destroy its adhesive properties. It is known that the spermatozoa live in weak solutions of various substances and that eggs are not readily killed by many such solutions. A considerable number of such substances was tried in very weak solution. Among them were common salt, chromic acid, chromic acid combined with salt, ammonium hydrate, potassium hydrate, sodium carbonate, sodium sulphate and egg albumen. But the experiments were fruitless, and it is not necessary to detail them here. A mixture of salt and chromic acid destroys the adhesion of the eggs permanently, but the spermatozoa do not live well in it, and the egg does not fill after its action.

2. It might answer to allow eggs to adhere to one another in a mass and afterwards to separate them by me-

chanical means, such as passing them through a sieve. This method has been pursued, as I learn from Mr. Stranahan, at the United States hatchery at Put-in-Bay, Ohio.

A trial showed that the eggs when separated are distorted by the mutual pressure. Some are elongated, others are flattened, and scarcely any are spherical. About 10 to 15 per cent. more of the eggs are injured mechanically than by the process next to be described.

3. It might be possible to add to the water some substance that should get between the eggs and prevent their touching one another. It was believed that the reason that the eggs did not adhere in milted water is that the heads of the spermatozoa attach themselves to the surfaces of the eggs, and thus so thickly studded with these little bodies that they cannot touch one another, and do not therefore adhere.

The alkalinity of the milt prevents the eggs from filling, and it was thought that perhaps some other finely divided substance not alkaline might be placed in the water to take the place of the milt. Trials were made of egg yolk. After fertilizing the eggs they were placed in water containing egg yolk in a finely divided condition. The eggs did not adhere, but they did not develop. Fine clay mixed with water was also found to be useless. The egg yolk probably failed through some chemical action on the eggs or milt. It seemed likely that the failure of the clay was to be attributed to the fact that the fine hard particles cut their way into the outer egg membrane and became so deeply imbedded in it that the eggs were able to touch one another and adhere.

Corn starch was then tried. About one volume of dry corn starch was added to 20 volumes of water. The eggs were fertilized in the usual way, and were immediately, after two or three minutes, poured into the starch water. Another lot of eggs was then fertilized and added to the starch water, and the work was continued until the pail

containing the starch water had been half filled. It was found that the eggs settled to the bottom of the pail and became thickly coated with the starch, which prevented their adhering to one another. The eggs could thus lie quietly, and the evil effects of the agitation were avoided. At the same time, by being placed in the starch water they were brought suddenly into a large quantity of fresh water, and the milt was thus washed off almost immediately, so that the water on the eggs was not alkaline. The starch in the pails settles slowly, so that after ten minutes there is much starch in the water at the bottom of the pail and but little in that at the top. The top water may then be poured off and fresh water added, and the egg and starch brought into contact with the fresh water by a few twisting and swinging movements of the pail. As the starch again settles, the water may be again changed, so that without using fresh starch there is a changing of the water every ten minutes, if deemed necessary. The eggs may lie in the starch water for four hours or longer, but at the end of two hours they were usually washed up to free them from starch. They were found well filled and developing normally; they had not adhered to one another and did not adhere when transferred to fresh water The starch appears to have no other effect on the eggs than to keep them apart.

Counts of eggs treated in this way showed between 15 and 30 per cent. more of fertilized eggs than were obtained by the usual method.

Here are two examples taken from a considerable number of experiments. In each case a batch of eggs was fertilized and then divided into two lots; one lot was then treated in the usual way, while the other was treated by the starch method:

TRIAL ONE.

BY THE USUAL METHOD.		BY USE OF STARCH.	
Segmenting.....112	63%	153	99%
Injured..... 2	1%	2	1%
Not segmenting..... 63	36%	0	0%
Total 177	100%	155	100%

TRIAL TWO.

BY USE OF STARCH.		BY THE USUAL METHOD.	
Segmenting..... 81	30%	39	15%
Injured... 18	6%	33	12%
Not segmenting.....176	64%	190	73%
Total 275	100%	262	100%

The first trial shows a gain of 36 per cent. (almost double the average), and the second a gain of 15 per cent. by the starch method. Three other trials gave each a gain of 15 per cent., and a fourth trial gave a gain of 23 per cent. By the usual method is meant that the eggs were kept in motion and the milt washed off rather slowly. A trial of the method of allowing the eggs to adhere, and afterward separating them, showed a gain of about 5 per cent. over the usual method, but a disadvantage of 10 to 15 per cent. as compared with the starch method.

Thus out of a considerable number of experiments there is an average gain of about 20 per cent. by the use of the starch method ; so that the method certainly merits a trial on a commercial scale. It is always possible to handle a small number of eggs, as a few thousands, in such a way as to secure a very large percentage of fertilized and uninjured eggs. The extreme care in manipulation, which is necessary to accomplish this, cannot be used where the number of eggs is so greatly increased and where the conditions for working are so unfavorable, as is usual in commercial practice. By the use of starch, eggs may be handled with very much less trouble than by the methods now in vogue, so that the method may be of value, even if

it is found in practice to produce no increase in the number of eggs saved.

During the present season Mr. Dwight Lydell, an employee of the Michigan Fish Commission, has kindly made for me some tests of this question, the results of which are as follows:

On May 13 about five and one-half million eggs were taken by the starch method at Roberts Landing, on the St. Clair River: these were shipped by steamer to Detroit and placed in closed jars. On May 24 the good eggs remaining in the jars were measured, and it was found to be 35 per cent. of the number placed in the jars. Eggs not treated by this method showed 30 per cent. of good eggs. The advantage of 5 per cent. thus apparently gained by the use of the starch is so slight as to be scarcely worth consideration.

It then occurred to me that perhaps the agitation due to shipping the eggs, and to the repeated handling in the hatchery in order to remove injured eggs, might be responsible for the loss. The eggs are usually shipped on the day following that on which they are taken. At this time the material which is to form the embryo lies on one side of the yolk in the form of a little disc or cap, the germinal disc. The rest of the yolk is covered by only a very thin layer of protoplasm, which is continuous with the germinal disc at its edge.

This layer of protoplasm is very easily ruptured so that the yolk protrudes through it into the space between the yolk and the shell. The yolk which thus escapes turns white and the egg dies. Early in the history of the egg the germinal disc extends itself over the yolk, and finally completely covers it. The yolk is thus protruded by a firm layer of much greater thickness than the original protoplastic covering. This layer is not easily ruptured, and the egg is consequently less liable to injury by mechanical means.

It takes about four days for the germinal disc to grow over the yolk and enclose it. It was thought that if the eggs could be kept quietly for four days at the point where they were taken, that they would be much more likely to withstand the subsequent transportation and the handling necessitated by running them in jars.

At my suggestion, Mr. Lydell on May 23, fertilized a batch of eggs by the use of starch. Seven pints of the eggs were placed in hatching boxes in the river, and three pints were placed on trays in shipping boxes. At the end of four days both lots were sent to the Detroit hatchery. When about to hatch, the good eggs were measured, and it was found that of those placed in hatching boxes there were three pints, or 43 per cent., while of those kept on trays there were 61 per cent. good. This is an average gain of about 20 per cent. over the average results of the last few years.

A second trial was made as follows: On May 5, 1,050,000 eggs taken with starch were placed in hatching boxes. On May 29 they were shipped to Detroit and put in jars until they hatched on June 2. Six hundred thousand, or 57 per cent. of these eggs were then found to be good.

Finally, it was thought that the advantage thus gained might be increased by holding the eggs in the hatching boxes until they were hatched. The first trial of this sort yielded 56 per cent. of good eggs by the starch method. The following comparative test was then made: On May 9 eight quarts of eggs were taken, four by the use of starch and four in the ordinary way. There was no other difference between the two sets of eggs. After they had filled they were placed in hatching boxes. On May 27 they were about to hatch. About 2,000 eggs were taken at random from each box after stirring the eggs in the box, and counted. The eggs taken were an average sample of the eggs in the box. Those treated without starch showed 50 per cent. of good eggs, while those that had been

handled by the use of starch showed 73 per cent. of good eggs.

It will thus be seen that the use of starch yields a uniform gain of about 20 per cent., provided the eggs are held for four days before shipping. This last experiment shows a still further gain of 20 per cent. when the eggs are not shipped at all, but are allowed to hatch in the boxes. There is no reason known to me why this method should not be pursued, and the eggs carried to hatching boxes until ready to hatch. They could then be transported in order to be planted.

I bring the method forward here in the hope that members of this Association will be led to test it, and I shall be glad to know the result of any such test.

The reading of Prof. Reighard's paper elicited the following discussion:

Mr. F. N. Clark—Mr. President, I have been very much interested in Prof. Reighard's paper. I wish to state in this connection my experience in transporting those eggs after they are well-developed. I have taken some of the pike-perch eggs from Detroit to Chicago, which were parts of lots that were taken by the Michigan Fish Commission on the St. Clair River. The last lot I brought here I delivered to Mr. Ravanel, and they were well-developed eggs, a part of them at least, and a part were not. When I got them here the starched eggs were very good indeed; just what percentage of good eggs there were I don't know, but those that were not starched were not as good, although they were very much better than the unstarched eggs brought earlier in the season, when there was no development at all. Some eggs, I believe, were brought the second day after taking, and I wish to say that I think it is conclusive to my mind that the moving of pike-perch eggs should be delayed until they are well-developed.

In this connection, I would like to ask Prof. Reighard if

it is not possible in most all of the egg development in our hatcheries that the membrane (I think you call it the membrane—I am not familiar with the scientific name), with our trout, for instance, where we are obliged to move the trout eggs, or agitate them at an early period after the eggs are taken, is not broken in being moved about, as well as pike eggs?

Prof. Reighard—I think very likely. I do not know of any eggs of the commercial fish handled that have not a structure practically the same as this. In all of them there is this thin membrane and yolk, and under that and practically independent of the membrane is a substance of a doughy consistency, and the rupture of the sac allows that to escape.

Mr. Clark—A year ago last winter we took and shipped eggs from a gravel box, probably 20,000 brook trout eggs, the second day after they were taken from the fish, and another box of the same size, taken at the same time, was left undisturbed. Of the first box we didn't hatch 30 per cent. of the eggs, while of the other we hatched 94 per cent. They were drawn with a syphon.

Mr. Page—Might I ask what kind of a box it is you keep eggs in?

Mr. Clark—A shad box.

Mr. Page—A Seth Green shad box?

Mr. Clark—Yes, with wire on the inside of the box, so the eggs can be turned over and the screen cleaned.

Mr. Mather—I would ask the Professor if he has ever seen any smelt eggs? They seem to throw out a little footstool.

Prof. Reighard—I have not. That is the case with some eggs; there is a hair-like projection upon them. I am not familiar with those eggs.

Mr. Mather—There is a lot of pedicle-like hairs thrown out from smelt eggs that occasions us a great deal of trouble in smelt hatching.

PROF. REIGHARD—I don't know that the starch would be of any advantage there. It might be that the threads themselves are adhesive, and it might be good.

MR. CLARK—Do you think that most eggs that are adhesive would be benefitted, that we could get better results by the use of starch?

PROF. REIGHARD—If they are adhesive in the same sense these eggs are adhesive, you could. Of course, if you get an egg covered with hair-like projections, it might not be of any assistance; but in any case where the membrane is fairly smooth, the starch is used with some advantage.

THE NORWEGIAN FISHERIES.

READ BY CAPT. J. W. COLLINS.

The occupation of fishing is, next to cultivation of the soil, the most important source of livelihood in Norway. According to usual calculations, the number of persons mainly interested in this occupation is one-fifth of the total population.

The fisheries contribute materially to the food of the people and also afford a considerable surplus for export. Until of late years the export consisted almost exclusively of salted and dried products. Strong efforts are, however, now being made to develop the export also of fresh fish.

With most of the other nations who carry on salt-water fisheries on a large scale the deep-sea fishery is the principal one, the fishing taking place in the open sea from decked vessels, usually owned by shareholders, the crew being also engaged on share. In Norway, on the other hand, the fishing takes place almost entirely on the coast from open boats, and the Norwegian fisherman owns, as a rule, his own boat and fishing tackle.

Of the descriptions of fish caught, the cod (*Gadus morrhua*) and the herring (*Clupea harengus*) are the most

important. While these fisheries were formerly of about equal importance to the country, the cod fisheries have in later years given a considerably greater result in value than the herring fisheries.

THE COD FISHERIES.

The great cod fisheries take place principally on the following three divisions of the coast, viz. :

1. The inner and outer coasts of the Lofoten group of islands, between 67° 25′ and 68° 36′ N. lat.

2. The coast line from Stadtland to the entrance of the Trondhjem fjord, including the districts of Sondmore, Romsdalen and Nordmore, or from lat. 62° to 63° 20′.

3. The coast of Finmarken on the boundary of the Arctic Ocean.

From time immemorial the cod has yearly, during the months of January to April, arrived in the first named regions (1 and 2) in large schools, to spawn. In Lofoten the fishing may be said to recur with perfect certainty every year ; it has, to be sure, been said that the fish has in some years been present only in smaller quantities, but it cannot with certainty be affirmed that it has in any one year entirely failed to appear.

The cod comes in to Finmarken in the spring months, in pursuit of the great schools of capelan (*Mallotus arcticus*), which serves it for food. Whence it comes and where it goes is as yet an unsolved problem.

The method of fishing, as well as the fishing tackle, are nearly the same for the different districts of the country. In the general collection exhibited in the Norwegian section by the Committee of Bergen for the participation by Norway in the World's Columbian Exposition, characteristic types of boats and apparatus will be found.

The Lofoten fishery is the most important and characteristic of all the fisheries of the country. Every year 7,000 to 8,000 boats manned by about 30,000 men meet to

take part in it. A multitude of fishermen's cabins—each of which serves as lodging for about twelve men—is erected around the fishing stations. Such a cabin may be seen in the Norwegian section of the Fishery Building, where it is used as an office.

The boats are: Gill-net boats with a crew of six to seven men, and a carrying capacity of six to seven tons; long-line boats with three to five men, and up to three and one-half tons capacity, and ordinary small boats for hook and line fishing, rowed by only two or three men. The usual depth in which the fishing takes place is forty to sixty fathoms.

It is estimated that nearly half the fishing time is lost on account of storms, but when the weather permits of uninterrupted fishing, the quantities that may be caught are perfectly astonishing. Thus there were, for instance, landed in Lofoten from the 13th to 22d day of March, 1880, nine and one-quarter millions of codfish.

The entire quantity of cod caught in the great Norwegian winter and spring fisheries was, for the five years 1887–1891, estimated to average about 56.2 millions fish per annum. Of such quantity about 75 per cent. is usually prepared as "Klipfisk" (salted split cod), and 25 per cent. as "Rundfisk" (round dried stockfish).

THE HERRING FISHERIES.

In the first half of the present century and as late as the close of the sixties, the magnitude of the spring herring fishery was relatively of such importance as to place the other herring fisheries quite in the shade.

The spring herring contains roe or milt, and derives its name from the season of the year in which it is fished, viz., from January to March or April. It is fished on the coast from the Naze to Stadtland, between 58° and 62° N. lat. Like the cod at Lofoten, its migration to the coast is for the purpose of spawning, but contrary to the cod, the

herring has in certain periods failed almost entirely to appear. It is said to have been absent from the coast from 1784 to 1808, and the same may now be said to have been the case since 1873, inasmuch as this fishery, which in good years gave a result of upwards of half a million of barrels, has during the last twenty years usually amounted to only 50,000 to 100,000 barrels. It remains for the future to satisfactorily explain the cause of this irregularity.

In the sixties the so-called "Storsild" (large herring, likewise containing roe or milt) began to come in to the coast of Nordland in immense schools. This fishery, which mainly occurred during October to December, became in short time of great importance. There were, for instance, in the first half of the seventies exported 300,000 to 400,000 barrels annually, and in 1872 even upward of 600,000 barrels. It fell, however, away just as suddenly as it had grown into importance, and in 1875 it ceased entirely.

The herring fishery which in later years has attracted the most attention is, however, the fat-herring (summer herring) fishery. It is no new fishery; in fact, very old, but as long as spring herring and "Storsild" was plentiful it was comparatively neglected.

Contrary to the first mentioned species of herring, the fat-herring is a matje herring, contains neither roe nor milt, but, when of the genuine description, its belly is filled with fat. The best fishing season is August, September and part of October, but it may occasionally commence even as early as July, and it very often extends far into November. This fishery takes place along the entire coast from Bergen to Tromsö, as a rule, however, between 64° and 70° N. lat. The export of fat-herring has, since the middle of the seventies, generally amounted to 500,000 and at times even up to nearly 1,000,000 barrels a year.

The Norwegian fat-herring, which is caught during the autumn months, when it is in its best condition, is con-

sidered to be the finest and most delicious of herrings.

On the southeastern coast of Norway, on both sides of the entrance to the Christiania fjord, a herring fishery has, since the beginning of the eighties, also been carried on with varying success. This fishery occurs about New Years. In 1891–92 the result was very good, and amounted to several hundred thousand barrels. The catch consists of large, full herring (with roe, or milt).

The Norwegian herring fisheries are carried on with gill-nets and drag-nets, perhaps principally the latter. Specimens of both kinds of apparatus are exhibited in the Norwegian section.

Sprats (Brisling—*Clupea sprattus*) are fished for in the autumn with small-meshed drag-nets, chiefly in the fjords between Stavanger and Bergen. It is a small, palatable fish, which is extensively used for anchovies and hermetical preparations. A portion of the catch is also salted in the usual manner.

The above mentioned fisheries (winter and spring cod fisheries and the herring fisheries) supply usually 75 to 80 per cent. of the total value of the Norwegian coast fisheries. The so-called summer fisheries—cod, ling, haddock, cusk, coalfish, sea perch (*Sebastes norvegicus*), halibut, flounder, etc., as well as the mackerel fishery, salmon, sea trout and lobster catch—supply the remaining 20 to 25 per cent. The total annual value of these fisheries has during the period 1887–91 averaged six and three-tenths millions of dollars, calculated at the prices paid at the fishing station. In this amount the home consumption of fresh fish and bait is not included, as this is not included in the official statistics.

Besides her fisheries, Norway also takes part in the following closely allied marine occupations: Whaling in Finmarken, sealing, bottlenose whaling and Arctic Ocean expeditions fitted out from Tromsö, Hammerfest and Vardö.

Whaling in Finmarken is carried on by means of small steamers about 30 tons register. The guns, harpoons and other apparatus used on board these vessels may be seen in the Norwegian section. This occupation dates from the close of the sixties, and has in the eighties been carried on by about thirty steamers, manned by about 500 men, with an annual catch of about 1,000 whales.

To take part in the pursuit of one of these mighty monsters of the deep, is one of the most interesting of sports. If the whale does not die at once, which rarely happens, it dives straight to the bottom and rushes off with the vessel in tow, at a rate which, although the engine works full speed astern, may reach fifteen to sixteen knots. One case has been reported in which this venturesome chase was continued uninterruptedly for twenty-four hours, when the towline was cut, the whale—a real cachelot (humpback)—seeming still in possession of its full strength.

Sealing is carried on in the ocean around the coast of the small island Jan Mayen, between 67° and 75° N. lat. and 5° E. and 17° W. long. (Greenwich). The number of the Norwegian sealers is a little over twenty, exclusively steamers from 200 up to 600 tons register, and manned by about 1,000 men.

Bottlenose whaling is carried on at about the same place as the sealing. The number of vessels engaged has in later years been about sixty, with a crew of about 900 hands; a few of these vessels are steamers, averaging a little more than 100 tons register. The annual catch has been in later years upwards of 2,000 whales.

The Arctic Ocean expeditions are fitted out from the Finmarken ports, Tromsö, Hammerfest and Vardö, with a number of large boats and about fifty small vessels, from thirty to forty tons register. The scene of operation is the Arctic Ocean, the White Sea, and the waters in the vicinity of Spitzbergen and toward Nova Zembla, where eiderdown is collected, fishing carried on and where the capture of the

Greenland shark, the walrus, seal, bottlenose whale, white whale (*beluga*), polar bear and reindeer takes place.

The value of the above named occupations was estimated in 1891 as follows:

The whaling in Finmarken	about $220,000
The sealing	" 250,000
The bottlenose whaling	" 200,000
The Arctic Ocean expeditions	" 100,000

With respect to the export trade, reference is made to the statistical tables hereto attached, which were prepared by the Norwegian Statistical Bureau in Christiania, and which give the quantities and values of the most important fishery products, as well as the products of sealing and whaling exported from Norway, in the period 1880 to 1891. As will be observed, the average annual value of the export in that period amounted to about $12,000,000, quite a respectable sum for a country of only 2,000,000 inhabitants. The fisheries products are also the most important articles of export from the country. Next to them come the products of the timber industries with about an equally large amount.

PUBLIC MEASURES.

It may be said that it is only within the last twenty years that the Government has taken any active steps for the promotion of the fisheries. Government superintendence, which, however, is chiefly to be regarded as a police measure, is established in connection with several of the large fisheries; telegraph and telephone lines have been constructed, postal communications extended and arranged with a special view to the fisheries; the sounding and laying down on charts of the ocean banks is proceeding rapidly; by means of official reports the public is kept posted on the progress and results of the various fisheries, and, if a large school of fish comes into a remote place, temporary telegraph stations are, if necessary, established there-

The statistics of the fisheries have been placed on systematic lines, which have gained general approval for exactness and completeness. Various laws have been promulgated. A small sum is appropriated annually for the purpose of practical scientific investigations. The long stretch of coast has been divided into four districts, for each of which an inspector of fisheries is appointed. A separate inspector, with two assistants, has, besides, been appointed for the fresh-water fisheries.

A law of May 24, 1873, provides for the establishment of harbor works, beacons and moorings in the fishing districts, the expenditure for which is covered by the interest from a special fund, which on June 30, 1892, amounted to $155,000, and from a tax placed on the products of the fisheries. The income from these sources has in the last years amounted to about $100,000 annually. It is expended, together with an appropriation from the public treasury, and is applied according to special instruction by the Storthing (Congress). The treasury appropriation is usually made in the proportion of one-third to two-thirds income from the special fund and taxes.

Three separate funds, with an average annual income of $50,000, derived from a tax placed on the fish products, provides for medical relief during the great fisheries. This relief measure embraces free medical care of all persons engaged in the fisheries, the establishment and maintenance of hospitals and, as far as the funds permit, other enterprises for the benefit and comfort of the fishing population.

Selskabet for de Norske Fiskeriers Fremme (the society for the promotion of Norwegian fisheries) was established in Bergen in 1879. It has thirteen branches and subdivisions spread over the country, and about 2,000 members. Its annual income now amounts to about $15,000. Of that amount 75 per cent. is Government grant, and 25 per cent. is derived from subscriptions and private contributions.

Several Fishery Museums have also have established. Since 1882 the Society has issued a quarterly magazine, *Norsk Fiskeritidende* (Norwegian Fisheries Magazine). The Government has established and provides for the maintenance of a fisheries laboratory, with a school of instruction attached, in Bergen, and a fisheries school in Nordland. A biological institute has also been established in Bergen, chiefly with the view of facilitating investigations of benefit to the fisheries. Foreign scientists have admission to this institute.

Fisheries exhibitions are frequently held in the country.

An import duty is placed upon salt, which goes to the treasury and amounts annually to from $80,000 to $120,000. As most of the salt imported is consumed in the service of the fisheries, and as no drawback is allowed on export, the greater part of this burden falls upon the fishing occupation.

KR. LEHMKUHL,
Chairman of Society for Promotion of Norwegian Fisheries, Bergen, Norway.

CAPT. COLLINS—I think, Mr. President, there are some sentences in this paper that deserve attention, and I would be glad to hear an expression from the gentlemen present concerning them. You will notice that a statement is made here that in that country there are maintained several fishery museums, and the thought has occurred to me whether it would not be a good thing for the State Commissioners—those men who are devoting the best years and the best efforts of their lives to promoting the advance and improvement of the fisheries and the maintenance of fish in our streams and lakes—to take some measures to collect, in a systematic way, such matter as they can which might in time constitute a collection worthy of the name of a museum, which would be almost invaluable for reference to their successors.

All of you know, of course, that in Washington there has been gathered a large collection of this character, but

it is not always convenient, I take it, for men interested in these subjects, who are carrying on the work in the States, to go to Washington to study any particular form of net or line or hook, or many other things which might naturally come up for consideration. I simply make mention of this to call the Society's attention to it in a special manner. The statement is also made, though it is known I think to every one here, that fisheries exhibitions are freqently held in the country. In this country, outside of the exhibition that is annually held at Newberne, N. C., I do not know that any attempt has ever been made to have what might be termed a fisheries exhibit, except in connection with some exposition. I believe it would be a matter worthy of consideration by this Society whether or not it would be beneficial to fishing and fishculture and its interests, to hold such exhibits from time to time in the different States. It may be true that it might not be possible to bring together such large collections as might be assembled at some particularly great international fisheries exhibition, but I believe it is true that if from time to time exhibits could be held embracing not only the living fish but also representative of the apparatus, methods of fishing and of fishculture, the public would be much edified, and the work which is being carried on in the various States could be made known to them better than it is now known. I think it is a duty we owe ourselves, that the Society should give this matter some attention.

TOTAL VALUES OF THE SEA FISHERIES OF NORWAY DURING THE YEARS 1880-1891.

(Oysters Excepted.)

YEAR.	CODFISH.	HERRING AND SPRAT.	MACKEREL.	THE SUMMER FISHERIES OF COALFISH LING, ETC.	SALMON AND TROUT.	LOBSTER.	TOTAL.
	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.
1880	12,540,000	7,103,000	696,000	1,448,000	382,000	405,000	22.574,000
1881	10,925,000	4,962,000	769,000	2,175,000	401,000	377,000	19 609,000
1882	12,724,000	3,451,000	699,000	2,491,000	321,000	423,000	20,109,000
1883	9,942,000	8,447,000	742,000	4,366,000	386,000	440,000	24,323,000
1884	15,536,000	4,295,000	735,000	2,899,000	495,000	418,000	24,378,000
1885	11,012,000	3,965,000	782,000	2,499,000	590,000	398,000	19,186,000
1886	12,570,000	5,549,000	765,000	2,465,000	493,000	428,000	22,270,000
1887	8,054,000	2,958,000	554,000	2,248,000	545,000	395,000	14,754,000
1888	12,911,000	4,637,000	719.000	2,535,000	632,000	414,000	21,848,000
1889	15,402,000	3,836,000	384,000	2,631,000	651,000	402,000	23,306,000
1890	14,075,000	4,141,000	512,000	2,448,000	656,000	366,000	22,198,000
1891	14,111,000	6,763,000	659,000	3,328,000	875,000	369,000	26,105,000

EXPD WHALE FROM NORWAY,

YEAR	CODFISH		COD-FISH ROE.	FISH GUANO.	SEAL AND WHALE BLUBBER.	FISH, SEAL AND WHALE OIL.	FISH OIL GROUNDS.	YEAR
	SALTED (KLIP-FISH.	HALE-ONE. S]						
	KILOG.	KILOG.	HECTOL	KILOG.	HECTOL	HECTOL	HECTOL	
880	52,962,300	19,21,720	77,630	8,769,990	12,284	168,555	1,303	1880
881	41,918,720	18,17,120	52,750	8,344,550	7,002	124,916	1,776	1881
882	40,120,360	14,46,900	66,451	6,232,600	11,188	100,775	15	1882
883	31,452,920	10,24,490	35,633	7,001,930	24,017	82,654	774	1883
884	37,665,880	13,35,700	40,125	8,081,200	18,712	125,262	173	1884
885	37,372,110	16,33,360	63,914	7,949,130	2,225	146,770	....	1885
886	41,491,200	15,21,560	59,203	9,052,250	3,242	168,565	....	1886
887	42,207,860	17,26,700	60,165	6,412,420	2,760	159,656	....	1887
888	42,817,520	20,91,420	52,023	7,845,490	3,967	201,583	868	1888
889	47,479,240	18,53,550	51,720	6,944,160	2,662	207,498	624	1889
890	55,577,120	18,89,960	87,706	8,630,680	846	236,701	818	1890
891	45,069,600	14,94,500	42,447	7,102,290	5,018	181,691	....	1891

EAR	CODFISH		FISH GUANO.	SEAL AND WHALE BLUBBER.	FISH, SEAL AND WHALE OIL.	OTHER PRO-DUCTS.	TOTAL VALUES.	YEAR
	SALTED (KLIP-FISH).	H D (S F						
	KRONER.	KRR.	KRONER.	KRONER	KRONER.	KRONER	KRONER.	
880	12,304,500	5,200	1,315,500	270,300	5,294,800	28,200	39,183,500	1880.
881	16,012,000	6,100	1,335,100	252,100	5,438,300	83,300	50,927,900	1881
882	17,653,000	6,700	1,121,900	402,800	5,382,500	86,700	48,198,500	1882
883	16,041,000	5,400	1,120,300	960,700	4,430,100	120,500	44,630,600	1883
884	13,183,100	5,600	1,131,400	636,200	5,706,300	182,000	41,910,800	1884
885	11,847,000	5,100	953,900	71,200	5,228,400	230,800	36,550,800	1885
886	10,787,700	5,300	995,700	100,500	5,140,500	172,000	38,207,800	1886
887	13,928,600	5,800	641,200	70,500	4,616,300	119,400	40,808,100	1887
888	15,414,300	6,700	863,000	119,000	5,609,900	96,500	47,125,700	1888
889	16,617,700	6,000	833,300	79,900	5,726,900	95,700	46,350,100	1889
890	17,784,700	6,700	1,078,800	25,400	6,811,800	108,900	49,242,200	1890
891	18,478,500	5,900	894,900	155,600	5,953,600	134,600	48,136,600	1891

EXPORT OF FISH AND THE PRINCIPAL PRODUCTS OF FISH, INCLUDING SEAL AND WHALE FROM NORWAY, DURING THE YEARS 1880–1891.

QUANTITIES.

YEAR	CODFISH.		HERRING.		OTHER SEA FISH PICKLED	ANCHOVIES, SPRAT, PICKLED	MACKEREL HERRING AND OTHER FRESH FISH, SALMON, EXCEPTED.	SALMON.		LOBSTERS FRESH.	FISH-MEAL.	SKINS.				WHALE-BONE.	COD-FISH ROE.	FISH GUANO.	SEAL AND WHALE BLUBBER.	FISH, SEAL AND WHALE OIL.	FISH OIL GROUNDS.	YEAR
	SALTED (KLIP-FISH.	DRIED STOCK-FISH.	PICKLED.	SMOKED.				FRESH.	SMOKED.			POLAR BEAR.	SEAL.	WALRUS.	WHITE-FISH.							
	KILOG.	KILOG.	HECTOL.	KILOG.	HECTOL.	HECTOL.	KILOG.	KILOG.	KILOG	NUMBER.	KILOG	KILOG	KILOG.	KILOG	KILOG.	KILOG.	HECTOL	KILOG.	HECTOL	HECTOL	HECTOL	
1880	52,962,300	19,252,490	536,333	115,691	118,348	11,755	2,218,830	283,230	407	1,990,784	1,278	1,472	470,934	36,880	26,065	21,720	77,630	8,769,990	12,284	168,555	1,303	1880
1881	41,918,720	18,876,200	1,090,623	354,109	167,275	15,574	1,976,100	379,670	2,980	1,001,981	1,108	176	229,031	37,300	18,840	17,120	52,750	8,344,550	7,002	124,916	1,776	1881
1882	40,120,360	14,907,170	719,095	153,857	113,755	10,859	1,870,580	254,820	1,707	1,324,454	2,180	128	390,396	20,830	3,710	46,900	66,451	6,232,600	11,188	100,775	15	1882
1883	31,452,920	10,907,280	663,982	123,436	80,158	9,141	1,965,450	424,480	1,418	1,089,391	1,200	288	542,412	66,910	27,380	24,490	35,633	7,001,930	24,017	82,654	774	1883
1884	37,665,880	13,874,890	740,807	147,122	92,962	9,313	3,774,540	447,130	1,195	940,160	1,130	479	492,777	7,610	22,140	135,700	40,125	8,081,200	18,712	125,262	173	1884
1885	37,272,110	16,829,890	697,532	223,236	87,609	11,124	7,048,305	627,080	930	835,398	830	1,885	241,433	30,000	15,160	83,360	63,914	7,949,130	2,225	146,770	....	1885
1886	41,491,200	15,869,330	811,156	586,001	129,002	11,066	16,086,690	523,320	2,200	1,150,957	778	869	350,917	38,230	10,740	121,560	59,203	9,052,250	3,242	168,565	....	1886
1887	42,207,860	17,477,300	1,126,002	1,174,492	116,247	18,269	11,624,250	657,010	2,788	888,163	2,360	656	373,253	86,290	2,280	126,700	60,165	6,412,420	2,760	159,656	....	1887
1888	42,817,520	20,434,150	888,328	1,799,392	129,558	12,069	3,492,190	732,000	602	935,404	1,025	576	503,441	18,451	12,950	91,420	52,023	7,845,490	3,967	201,583	868	1888
1889	47,479,240	18,346,960	1,054,695	1,774,147	126,380	19,809	9,397,400	692,360	801	759,910	735	1,794	404,584	46,508	2,772	53,550	51,720	6,944,160	2,662	207,498	624	1889
1890	55,577,120	18,565,870	829,145	2,196,686	150,917	16,991	8,036,530	758,610	1,222	660,055	528	491	440,750	17,770	3,890	89,960	87,706	8,630,680	846	236,701	818	1890
1891	45,069,600	14,400,100	788,809	1,558,703	136,049	11,854	10,907,550	1,026,790	1,326	566,703	11,554	1,271	465,851	26,840	617	94,500	42,447	7,102,290	5,018	181,691	....	1891

VALUES.

YEAR	CODFISH.		HERRING.		OTHER SEA FISH PICKLED.	ANCHOVIES, SPRAT, PICKLED.	MACKEREL, HERRING, AND OTHER FRESH FISH, SALMON EXCEPTED.	SALMON, FRESH.	LOBSTERS, FRESH.	SKINS.			WHALE BONE.	CODFISH ROE.	FISH GUANO.	SEAL AND WHALE BLUBBER.	FISH, SEAL AND WHALE OIL.	OTHER PRODUCTS.	TOTAL VALUES.	YEAR
	SALTED (KLIP-FISH).	DRIED (STOCK FISH).	PICKLED.	SMOKED.						SEAL.	WALRUS.	WHITE-FISH.								
	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER.	KRONER	KRONER.	KRONER.	KRONER	KRONER.	KRONER	KRONER.	
1880	12,304,500	5,274,200	9,504,200	37,000	805,900	704,100	461,900	453,200	396,300	526,600	9,200	49,500	195,500	1,552,600	1,315,500	270,300	5,294,800	28,200	39,183,500	1880.
1881	16,012,000	6,134,800	16,280,300	113,300	1,574,200	734,500	418,700	569,500	400,800	301,200	11,200	22,600	154,100	1,091,900	1,335,100	252,100	5,438,300	83,300	50,927,900	1881
1882	17,653,000	6,727,100	12,150,900	55,400	812,800	523,100	447,800	407,700	529,800	620,700	16,700	5,900	24,400	1,229,300	1,121,900	402,800	5,382,500	86,700	48,198,500	1882
1883	16,041,000	5,487,900	11,567,000	49,400	566,900	306,000	516,800	551,800	490,200	745,800	60,200	38,300	9,800	1,567,900	1,120,300	960,700	4,430,100	120,500	44,630,600	1883
1884	13,183,100	5,625,400	10,555,700	44,100	608,700	251,400	772,700	625,900	441,900	492,800	6,800	26,600	95,000	1,524,800	1,131,400	636,200	5,706,300	182,000	41,910,800	1884
1885	11,847,000	5,122,500	8,128,500	58,000	574,500	318,000	1,198,900	783,900	401,000	289,700	24,000	15,200	58,400	1,246,300	953,900	71,200	5,228,400	230,800	36,550,800	1885
1886	10,787,700	5,387,100	9,625,600	117,200	854,600	287,860	1,945,100	680,300	517,900	386,000	22,900	11,800	109,400	1,065,700	995,700	100,500	5,140,500	172,000	38,207,800	1886
1887	13,928,600	5,883,500	9,777,400	234,900	765,700	348,400	1,226,600	854,100	444,100	466,600	38,800	1,800	126,700	1,263,500	641,200	70,500	4,616,300	119,400	40,808,100	1887
1888	15,414,300	6,719,500	11,217,700	449,800	1,099,200	391,500	1,783,500	951,600	561,200	704,800	8,300	10,400	137,100	998,400	863,000	119,000	5,609,900	96,500	47,125,700	1888
1889	16,317,700	6,095,100	10,865,400	283,900	1,290,800	531,900	1,053,800	1,003,900	455 900	505,700	20,900	1,900	85,700	801,700	833,300	79,900	5,726,900	95,700	46,350,100	1889
1890	17,784,700	6,703,200	10,313,900	395,400	1,593,400	321,400	845,300	1,137,900	429,000	440,800	8,000	2,900	188,900	1,052,500	1,078,800	25,400	6,811,800	108,900	49,242,200	1890
1891	18,478,500	5,995,900	9,782,600	311,700	1,733,200	237,800	1,142,200	1,386,200	379,700	559,000	10,700	400	203,200	776,800	894,900	155,600	5,953,600	134,600	48,136,600	1891

PLANT YEARLINGS WHERE NEEDED.

BY WM. F. PAGE.

The term "yearling" as heretofore used (and as must from the necessity of the case continue to be used) is faulty in that it signifies only that the fish under discussion has reached a certain age, acquired a certain degree of intelligence, and cost a certain sum for attendance and food. The cost of a yearling will depend, other things being equal, upon the general cost of living in the locality in which it has been grown. The intrinsic value of the yearling for stocking purposes, if normally developed and in health, should depend upon its size, as it certainly would if the fish were to be used for the table. Latitude and elevation above the sea regulate to a large extent the possibilities of any particular hatchery for raising fish within a stated period to a given size. There is in the United States a variation in this respect of nearly 1,000 per cent. All consideration of the relative values of fry and yearlings for stocking purposes should be confined to the product of some particular hatchery or at least hatcheries under like climatic and hydrographic conditions.

In the past, particularly at the last meeting, the opponents of raising fish to yearlings prior to planting have used arguments which would fall under the following heads:

(a) The excessive cost.

(b) Its want of analogy to other processes.

(c) The large number of fish which would avoidably be lost, and

(d) Its want of permanent and commensurate results.

To an answer to these points I ask your attention.

The main element of cost heretofore discussed has been that of food. It is, in fact, almost, if not altogether, the chief factor of expense in raising from fry to yearlings. The attendance need not be counted (except perhaps in

some particular case), for the preparation of the food and the feeding of it to the fish can safely be intrusted to the care-taker, who looks after the brood stock and other property.

There are among fishes, in common with other animals, several dietaries, some followed from a matter of choice, some from necessity, and others from ignorance on the part of the attendant. They may for convenience be thus classified: First, bare subsistence diet, merely sustaining life and resulting in stunted, deformed fish or starvation; second, healthy diet, promoting normal growth and development; third, fattening diet, fitting for heaviest marketable weight, and fourth, over-fattening diet, causing a temporary or permanent suppression of the functions of the reproductive organs, a partial or total destruction of the eyes and inflammation of the intestines, frequently resulting in death. The first and fourth of these diets have killed very many fish, the second has hurt none and the third is outside the proper object of this paper. The question largely turns upon what constitutes a healthy diet? What does it cost? and is that cost excessive? No phase of this question is more obscure, more diversified in practice or richer in possibilities.

In the following paper, wherever reference is made to the "daily rations," "allowance," or "formulas," the amount and proportions given apply to yearling trout unless otherwise stated, the intention being to express only the artificial food supplied without taking into account the natural food the fish secure. Nor have I considered the highly important though ever-varying elements of "initial vitality," "range," and "space" in discussing the growth and size acquired by fish at different establishments. It will rarely or never happen that these conditions are identical at different establishments, for we know that at any one they are found varying from year to year and frequently in the same season. In our considerations of ar-

tificial food and growth we must for the present disregard, or assume as constant, the initial vitality, natural food, range and space.

For convenience of study I have adopted as a unit "the average daily rations in pounds per thousand yearling trout." I am aware that the unit would be more expressive and exact if it were based upon the number of pounds of fish rather than upon the number of fish to be fed. I have the data of the amount and character of food and rate of growth of the fish at sixteen trout-cultural establishments in the United States and Great Britain, the régime and results of which may fairly be assumed as typical of fishculture in general. These data present the astounding variation in the daily rations per thousand yearlings of from 2¼ oz. of animal (or flesh) food, in ponds containing very little natural food, to 10 lbs. of animal food in ponds abounding in natural food. I have calculated the weight of one thousand of the average yearling trout raised at these places to be 52.75 lbs. and the average daily rations to be 3½ lbs. In other words, the average allowance for yearling trout is 6½% of their weight. This, it seems to me, is out of all proportion to their necessities, and certainly is not warranted by analogy. It is true, as before pointed out, that the rate of growth depends to a large extent upon the location of the hatchery, and the corollary follows that the food allowance will also vary with the location. The allowance of a hatchery in a warm section cannot be considered a guide for one in a colder or more elevated region. For instance, trout reared in the Ozarks acquire a weight 700% in excess of those grown in the mountains of Colorado. The Colorado trout could not consume the allowance of the Ozark trout, and the Ozark trout would stunt or starve on the Colorado allowance. On this subject Mr. Stone says in "Domesticated Trout" (page 236): "The quantity [of food] varies with the season, the quality, quantity and temperature of the water,

and other circumstances, and cannot be definitely stated. Green says 5 lbs. for a thousand two-year-olds. I should say this would be an average feed through the year. I think it safe to say that under favorable circumstances large trout of any age will eat 1-50 of their weight in summer, that 1% of their weight will keep them in good condition through the year, and that they would do very well on half that allowance." Dr. Slack, in his book, "Trout Culture," stated that his brood stock throve very well on $\frac{1}{8}$ of 1% of their weight per day.

In the report of the United States Commission of Fish and Fisheries for 1884 is a translation of Mr. Carl Nicklas's book entitled "Pond Culture." In this work Mr. Nicklas enters exhaustively into the character and quantity of food necessary for fish On page 112 he says: "As there are no data on the subject, it will be difficult to lay down exact rules as to the quantity of food. It will be correct to presume, at least approximately, the same principles will have to serve as a basis as those prevailing in the feeding of cattle, and we shall, therefore, be enabled to fix a standard which will come as near the true one as possible." Reasoning on this basis, Mr. Nicklas concludes that 1,000 lbs. of carp will require 15 lbs. or 1½% of their weight of food per day. When we consider that a carp will consume, and probably requires, more food than a trout, we see that these three writers are in fairly close accord; and that the average practice of feeding 6½% of their weight to trout is in excess of the amount required. However, it must not be forgotten that these growing yearlings would most likely need a higher per cent. than the matured fish; but I cannot believe that the process of growing would require six times the material found necessary for maintenance after growth was accomplished.

So much as to the amount of food necessary, and that given in actual practice. Let us look now at what constitutes the food of trout under domestication. At sixteen

places I find liver is used. Curd, horse meat and mush at three place. Maggots, mussels, boiled fish and hens' eggs are each used at different places. At four of the places natural food is very abundant in the waters and largely depended upon for a portion of the year. You are all familiar with these various forms of food, and I shall not make further reference to them except to touch upon the points of natural food and the mixture of vegetable and animal food for trout. No little was said in the meetings of 1891 and 1892 upon the former subject, and I should not now refer to it except that on the part of some an incredulity was expressed as to the possibility of producing an adequate amount of natural food for more than a few hundred fishes. The following letter from Mr. Andrews will, I hope, satisfy the incredulous on this point:

WESTGATE HOUSE, Guilford, England, May 6, 1893.—Dear Sir: In reply to yours of April 18, it gives me great pleasure to comply with your request, and if the following is of any use to you I shall be very glad. I presume you have kept a copy of your letter to me, and I therefore simply answer your questions as numbered.

1. I have two hatcheries, the principal one being at Guilford, with capacity for hatching between 3,000,000 and 4,000,000 ova. The other hatchery is at my ponds at Haslemere, and is smaller.

The principal rearing ponds, and also ponds for the larger fish, are at Crichmere, Haslemere, and are from 200 to 300 feet above sea level.

3. Temperature of the hatching water at Guilford is pretty uniform at 49 to 51°. Temperature at my ponds varies from 49° in winter to 56° in summer. Occasionally it rises 2 or 3° higher, but very seldom.

The quantity of water passing through my Crichmere ponds amounts to nearly a million gallons per diem, and is only very slightly affected by a long drought and not to any visible extent. The place is, moreover, not subject to

flood, as all the springs rise on my grounds. The same applies to the other places which I use as fish farms.

4 and 5. I cannot tell how much liver and horse flesh is given to the yearling fish, but as natural food, viz., *Gammarus pulex*, *Limnæa* and larvæ of all water insects are present in great quantities, I can safely say the artificial food given to the fry is very, very small, and in two out of the three of my sets of ponds no artificial food whatever is given to the fish. We cultivate the natural food to a large extent, leaving one or more ponds every year for the purpose, and it is not an uncommon thing for us to transfer 150 gallons of *Gammarus pulex* and 20 bushels of *Limnæa* from one pond to another.

6. We get yearling fish of *fario*, *levenensis*, *fontinalis* and grayling from 4 in. up to 8 and 10 in. in length in 10 to 11 months, and there is very little difference in size of the four varieties above named. I do not care for the *S. irideus*, and have only had a few which were given me by Sir Jas. Maitland some four or five years ago. I need hardly say that the best yearlings are from fry planted in January and February, and the smaller yearlings are from fry planted later. Our fish begin to spawn late in October, and I have taken eggs as late as March 20, but I place less value on these late ova.

7. Weight of 5 in. yearling is about 350 grains, sometimes 450 grains, and this will apply to *fario*, *levenensis* and *fontinalis*, but grayling are a little lighter, being a slighter made fish. We include *levenensis* in the *fario* variety.

American *fontinalis* do well with me, reaching a large size, and I have breeders of this kind of 4 and 5 lbs. Many of my two-year-old fish weigh 1¾ lbs. and 2 lbs. in the second year, but I do not supply fish as two-year-olds over 12 in. I am, dear sir, yours very truly,

(Signed) Thos. Andrews.

It must be evident, I think, to every progressive fishcul-

turist that a change is coming over the spirit of the dream of fishculture, and in view of the fact that this change has its origin in, and is spreading from, the Old World, we must look at our laurels or else abandon the boast that we are the most advanced nation in fishculture. Only one thing can be urged against the new departure, and that is the cost of the land and the construction of the larger plant necessary for such a self-feeding establishment. But when we reflect that in cramped Great Britain private individuals without Government aid have successfully accomplished this thing on a paying basis, we must acknowledge that in broad and comparatively scantily populated America it can be done. If fishculture as a private business expands in this country as I hope to see it, the artificial propagation of natural fish food will be undertaken and accomplished. And to him who first does it will come the cream of the profits of the business. It will be by this process we will secure a rational, healthy diet at a minimum cost.

But however willing and ready we might be to take up the propagation of natural fish food on a scale commensurate with the demands, such an undertaking would necessarily be slow in its accomplishment, and probably considerable time would elapse before it became sufficiently developed to be understood and relied upon. In the twentieth meeting Mr. Seal told us how easy it was to secure a start and propagate natural food in any desired quantity. My own experiments fully confirm his statements, and by consent of the Commissioner I hope soon to test them on a larger scale. In the last meeting Mr. Fairbank told us how abundantly and cheaply this food produced itself at his place, and how well his fish throve upon it. Pending the development of this new method, which I feel sure will yet be undertaken and prosecuted by Americans, I submit for your consideration the methods of feeding trout as practiced at Wytheville and Neosho Stations,

of the United States Fish Commission, and also at the Troutdale Fish Farm, at Mammoth Spring, Ark. The method followed at these three places is not, so far as I know, prosecuted elsewhere; the differentiation consisting in an admixture of vegetable matter with the flesh or animal matter, heretofore constituting the sole food for trout under domestication. A few notes on the methods of preparing and administering this food at the Neosho Station will illustrate the method of the three places where it is used. A thick mush is made by cooking "shorts" or mill-middlings in boiling water, which, after it has thoroughly cooled and stiffened, is mixed with liver ground to a fineness suitable to the size of the trout to be fed. The very young trout have never been subjected to this diet (though it is not doubted that they could be induced to eat it), but they are started and kept upon a pure beef liver diet until they are thoroughly trained to congregate for their food. When the fry have been on liver for about two months, we commence to mix in a little mush, and gradually increase the proportion of mush (and quantity of food) until by the time they are six months old the mush and liver are in equal proportions. After that time the addition of mush is made freely, so that when the fish are yearlings the liver may be reduced to a minimum.

Exigencies have arisen, making it desirable to economize on liver. At such times we have not hesitated to put the trout on a diet of pure mush. They do not allow this food to sink to the bottom and eat it only when pressed by hunger. On the contrary, they rise to the surface, sometimes eat it in the air, and rarely or ever allow a particle to reach the bottom. To 1,000 yearling trout we have been giving a daily average of 1.87 lbs. of this mixture, in the proportion of 3.79 mush to 1.0 liver. Their average length at one year old was 6 in., and the weight for an average 1,000 was 51.86 lbs. The loss in raising 40,000 trout to

yearlings on this diet was 6 per cent. of the number of fry. That the fish produced by this diet were normal and healthy is beyond all question, and if evidence is wanted it is to be found in that their progenitors, spawning them at two years old, were raised on the exact same diet. The natural question is, what does this food cost? Shorts cost at Neosho, Mo., 90 cents per 100 lbs. One pound of shorts makes 3.6 lbs. of mush. Mush therefore costs one-quarter of a cent per pound. Liver during 1892 was delivered in Neosho from Kansas City for 3½ cents per pound. From this I deduce the cost of an average daily ration for 1,000 yearlings was 1.707 cents. If this food is not cheap enough to suit your views, I then ask your attention to the following condensed history of an experiment in feeding trout which I undertook last summer. On August 9, 12,000 healthy trout fry which had up to that time received the same general treatment and allowance of food as we usually give, were deprived of all animal or flesh food. From that time until they were shipped in February, 1893, not an ounce of animal food was given them, and it is certain that the natural animal food which they might have obtained was the very least. Their allowance throughout this time was 45 lbs. of mush per day, costing a fraction under one cent per 1,000 fish per day. At the end of the year they averaged 4 in. in length, and an average thousand fish weighed 27.5 lbs. The fish were normal and healthy, and though under the average size for Neosho, they were above the average of at least two American establishments.

In closing this branch of the subject, let me say that the food composed of a mixture of animal and vegetable matters more nearly approximates than any other artificial trout food in use, a rational, healthy diet; and when we consider its capabilities of creating and sustaining the heaviest growth in the shortest time, we must admit that it is not an extravagant diet. A study of Mr. Nicklas's article heretofore referred to conclusively shows that fishes

need the smallest proportion of hydrate of carbon; and further, that the best fish food is that containing the largest proportion of nitrogenous materials. He says on page 111: "The most suitable articles of food are blood, horse flesh, fish guano, curds, meat dried and ground fine, refuse from slaughter-houses, etc. All these, however, require to be mixed with other articles of food containing less nitrogen, so as to restore the proper proportion of nutritive substances. On the whole, the food for carp will have to be mixed very much on the same principle as that for cattle and other domestic animals." (In the passage just quoted Mr. Nicklas has reference to carp, but his remarks apply with equal or greater force to trout.) This is just what we claim to be doing in mixing mush with liver. It is probable that we are not at present combining these elements in the best possible proportion for fish, the Neosho formula being 1.0 meat to 3.79 mush, yet I believe we are using a more rational and inexpensive diet than is to be found in any one element of animal substance. If you answer me that the trout is naturally a carnivorous animal, I reply by reminding you that the trout we feed in our ponds are domesticated animals. The jackal and the wolf are carnivorous, but your domesticated dog sickens and dies when restricted to the only food acceptable to his ancient progenitors.

Is the cost excessive? That is something every man must work out for himself. In commercial fishculture the problem is soon solved by reference to the cash account. In governmental work it is a matter between the authorized agents and the legislative body controlling. It depends upon so many things that no one can say the cost is or is not excessive except for a particular locality. A food which we can well afford to use in Missouri is found too costly in the East.

Leaving then the question of expense, let us see wherein does the planting of yearlings lack analogy to other pro-

cesses. Last year the attempt was made to draw a comparison between stocking a stream with fish and raising an orchard, and with the parallel but half drawn it looked rather adverse to the yearling idea; but had the parallel been carried to its legitimate conclusion we would have seen that the young trees to thrive were in constant need of attention and protection. Food, water and protection from enemies all young trees must have, or only the fittest survive. Forgetting or ignoring these fundamental principles of husbandry, it was concluded that because one could raise large trees from small ones, therefore one could to the best advantage stock wild waters with infant fish. There is no true simile at any point between the two processes. In the former case we domesticate the trees, and in the latter case we naturalize the fish. These are widely divergent processes, in so much that in naturalization we omit, or at least, do not extend, the protection always accompanying domestication. A fair comparison cannot be drawn between the two. A fairer comparison might be found in the colonization by man of new countries. Who among the advocates of infant fry planting would support a scheme for colonizing a new America by sending out a cargo of babies? Let us look at this simile and see if it won't parallel better than that of the orchard. The history of the early colonization of this continent and Australia contains accounts of the death from disease, enemies and murder by savages sometimes of entire communities. Truly these were "lambs placed in the lion's den for safekeeping," somewhat on the order recounted (page 83, twenty-first meeting) of planting two-pound lake trout in a lake infested by pickerel. The moral is, if you will put your lambs into lions' dens, don't think it strange if others put their sheep into a sheepfold. But, further, we see that wherever on proper lines colonization has been undertaken, success has crowned the effort, and so it will eventually prove in the naturalization of fish.

As a practical workman, I wish to enter my negation to the doctrine advanced in this Association in the past of the very large percentage of loss unavoidable in raising fry to yearlings. One member last year said if you have good luck with 1,000,000 fry you may have 600,000 fish at the end of the year. In other words, a loss of 40 per cent., and another member placed the unavoidable loss at 50 to 75 per cent. I prefer to look upon these statements as fancy born and not as the expressions of experience. Twenty-five years ago they might have held good. But to-day, with proper appliances and a proper understanding and knowledge of the work, a loss of 75, 50 or even 40 per cent. from fry to yearlings should be considered inexcusable. (This be it understood to apply only to the product of such eggs as have not been subject to transportation.) As touching this matter, I ask your attention to the following quotation from Mr. Livingston Stone's work, "Domesticated Trout" (third edition, page 190): "I must, nevertheless, venture to disagree with them if they mean that there is any necessary inherent cause of death in the young fry which cannot be removed. Some will die, say 5 per cent., though it ought to be less than this, of weak constitutions. They are born into the world so weakly constituted that they cannot stand the wear and tear of life, and must die. I admit there may be perhaps 5 per cent. of these necessary, unavoidable deaths; but that the rest come into being already doomed to premature death, or that young trout have any mysterious or peculiar inherent cause of death in them, any more than young calves, or pigs, or chickens, I do not believe. In the present state of information of the art, young trout fry may be more liable to accidents than other young domesticated creatures, and it may be more difficult to guard against their diseases, but this is another thing. Careless breeding may, and careless hatching will, produce a progeny of young trout of which 90 per cent. will die; but this is also an-

other thing. Careful breeding and hatching will produce trout which are just as likely to live, in my opinion, as the same number of lambs or chickens; and if the young fry die it is not because of any mysterious, innate cause peculiar to them because they are trout, but it is because they were killed, deliberately killed, by external causes, just as much as lambs or chickens are killed by storms, or by parasites, or from starvation or poison. It is true that they are killed from ignorance of their wants, and not from wilful neglect, but it is the same thing abstractly—the cause of death is external and removable, and not innate and necessary. Their wants are peculiar, of course, and more occult and intangible than those of pigs and colts, and to a beginner it will sometimes seem as if they died without being diseased. But if they were as large as pigs and colts and could be studied as easily, I do not think their wants would be found to be any more mysterious or peculiar: and if the cause of disease could be magnified, so as to be observed and studied clearly, I think that no more trout would die when nothing was the matter with them.

"I am further convinced that study and experience will eventually clear this subject, notwithstanding the difficulties which surround it, and that at some time it will be known how to raise trout and make them live, as well as is known how to raise turkeys and chickens. I believe that there are energy and intelligence enough now interested in the cause to accomplish this end. I take this ground, partly because any other is unphilosophical and uncomplimentary to the intelligence of those who are studying the art, and partly because the facts of experience confirm it."

On page 149 of the "History of Howietoun," Sir James Maitland, speaking of a loss of 20 per cent. in a particular lot of *S. levenensis*, says: "This is a very heavy percentage, and is probably 8 per cent. too high," and in another place he gives his losses as 11 per cent. and 13 per

cent. My own experience with healthy eggs and fry is that the loss should not reach 10 per cent. These figures are not guesses. They are founded on actual counts. My method is this: In the spring, about or a little before the average time of planting fry, our young trout are transferred from the hatching troughs to the outdoor pools. We commence by taking out 500 of the most advanced fry and putting them into a pool by themselves. No other fry are added to them until they have been taught to readily congregate in the pool for their food. This training occupies two, three, four or five days, depending upon the fish and the condition of the weather. When they are thoroughly trained in this, a thousand more fry are added. It is expected, and rarely fails, that the 500 trained fish teach the 1,000 new fish to assemble at feeding times. Day by day we add fry in lots of 1,000 until the pool receives its quota. Now, the test of the whole matter comes in the succeeding fall, when the messenger brings his orders for so many yearling fish. Let us suppose his order calls for 5,830 fish. Then, that is just the number which we give him. But how? As a shipment of fry was formerly determined by counting a pan of 500 and estimating the balance? By no means. The fish are counted. At the Neosho Station three men ordinarily require less than two hours from start to finish in counting and loading an average carload of yearlings. The captain of the car is at liberty to supervise and check the count. At its completion he gives a receipt for the number of fish. This receipt is subject to a check in that the messenger must obtain a receipt or receipts from the final recipient or recipients of the fish for the like number, or stand the onus of having lost the fish in transit. The total of the receipts given by the messengers, subtracted from the total of the fry counted into the pools, represents the loss in raising from fry to yearlings. A little while back I made the statement that this loss need not exceed 10 per cent. Let us see what

this loss has been during the history of the Neosho Station. In 1890, on rainbow trout, 9 per cent.; in 1891, on rainbow trout, 7 per cent.; on Von Behr trout, 34 per cent.; on brook trout, 26 per cent.; in 1892, on rainbow trout, 6 per cent., and on brook trout, 8 per cent. The average of these six instances is 15 per cent. This is 5 per cent. too high, and was occasioned by the excessive loss of 34 per cent. and 26 per cent. respectively, in the Von Behr and brook trout of 1891. In the report of these two lots of fish, written before this loss occurred, it was stated that they were very inferior lots of fish, with low degree of vitality, and unlikely to reach maturity. But the rainbow eggs of the seasons of 1890 and 1891 were strong and healthy, and their fry suffered a loss of only 9 per cent. and 7 per cent. respectively. The lowest loss, 6 per cent., was in the lot of rainbows raised from eggs spawned at Neosho—from eggs which had never undergone transportation. I have a belief that the very best results in fishculture will be attained by hatching from eggs which have not been subjected to transportation.

The successes which have attended our methods of raising trout fry to yearlings in pools are in the nature of a guarantee or proof that in principle it is very near correct. How different it is from the practice of planting several thousand fry at one time in one place. Some eighteen years ago, when we were getting ready a shipment of California salmon fry, an old gentleman who frequently visited the hatchery asked, "Who's going to stay down at the river to care for those minnows and chop liver for them?" The question at that time provoked a smile; but to-day, in all seriousness, I ask it of the advocates of fry planting. Who is to take care of your fry after they are planted? In this connection, it was well pointed out in the last meeting that the condition of the fry when planted was such that they must have food at once or they perish, while, on the other hand, the yearlings are in condition

to go without food for a considerable length of time. It has frequently happened in the past, and will I fear frequently happen in the future, that a plant of fry has been dumped in a stream at some point instead of being properly scattered in the smaller streams. Two of the best writers on trout-culture have hinted at the danger of this. In the "History of Howietoun," this significant passage occurs (page 69): "It must never be forgotten that fry of salmon and trout do not roam in search of food, but take up fixed positions, and snatch at particles carried past by the current; and they do not forage like yearlings until they are three or four months old. Many of the failures in fishculture are attributable to this habit being overlooked, although as early as 1873 it was noted by Livingston Stone, who says ("Domesticated Trout," page 171): "As they continue to grow, they increase their range, and by the first of September or a little later, they take their food like old trout." Now, what are the consequences of these fry thus taking up a fixed abode for several months? Unless the number be small or the food be unusually abundant, some of those which escape the thousand and one dangers of the fry stage will be stunted and never attain any size. But of the vast majority, what? They simply go to join the vast majority on the other side of trout life. Listen for a moment to a partial list of the destructive agencies which are waiting, watching and searching for them. But no, I won't inflict you. Their name is legion. You all know some of them, but none of us know them all. During the past four years we killed at Neosho Station 530 predatory birds, 239 piscivorous snakes, 2,500 lbs. of crayfish, besides very many other enemies. We try to exemplify the motto that "Eternal vigilance is the price of fish." And yet we lose young carp, tench, bass and other pond fish. Lose by the hundreds, yes, thousands. Not from disease or inherent weakness, but by enemies so insidious, so persistent, so minute, so numer-

ous, that we cannot totally eradicate them. Gentlemen, you will find it an enormous task to rear enough fry to counteract the destruction caused by natural enemies, and especially so unless all your plants are made under the best conditions, with the greatest care. You will find also that the cost of distribution when your fry are thus planted to the best advantage will commence to approximate the cost of distributing yearlings. Stocking a stream with yearling fish requires every degree of careful forethought; but stocking a stream with fry demands an intimate knowledge of the stream and its inhabitants, a more careful and wider distribution of the plant, and in many cases an accompanying or prior deposit of natural food adapted to infant trout diet.

In the Transactions of the Twenty-first Meeting of this Society, on page 113, occurs the following quotation: "I have seen it stated that in some of the streams of the Yellowstone, or West, several attempts were made to plant with fry, which failed, and other attempts made with yearlings succeeded. Now, the question naturally arises, suppose those yearlings do succeed and spawn there, what is to become of their fry when they are hatched? * * * It strikes me * * * if the fry cannot live in those streams, and nothing but yearling can, you have got to put in yearlings there every year." The foregoing remarks, no doubt, had reference to the plants of yearling trout made in the waters of the Yellowstone National Park by the United States Fish Commission in the autumns of 1889 and 1890, a concise history of which can be found in the Report of the United States Commissioner of Fish and Fisheries on the Explorations in Montana and Wyoming in the Summer of 1891 (Senate Mis. Doc. No. 65, pages 51, 52 and 53). I do not know the authority for saying these streams had hitherto been unsuccessfully tried with fry—though possibly they had. But I have the very best authority for saying that in at least one of these streams most unfavor-

able conditions prevailed for stocking with fry, and in one other the conditions were adverse for stocking with yearlings. One of the streams, the Upper Gibson River, contained the blob, or miller's thumb (*Cottus bairdi punctulatus*), and in the other, the Yellowstone River, the native mountain trout (*Salmo mykiss*) was abundant. The infernally destructive propensities of the miller's thumb are too well known to need remark here. The native trout of the Yellowstone has well been called voracious, and to him has been credited the destruction of at least one entire plant of fry. Prof. Everman, reporting on his reconnoissance of these waters, made in the summer of 1891, says: "At least the brook and Loch Leven trout, which were planted in 1889, spawned in 1890, as we found young of these species that could not be over a year old." Here is definite proof that yearlings planted in a stream are capable of reproducing and rearing their young, under conditions which would have, we may fairly say, been detrimental if not destructive to a plant of fry. How this was accomplished will, I think, show why it will not be necessary to annually restock a stream with yearlings because fry would not primarily live in it. That the trout do not exercise any direct parental care (one of the most potent and necessary factors in the reproductions of animals in general) I freely concede, and yet more freely that the young fry are under natural environment at all times the prey of numberless enemies. It is not asking too much to suppose that the yearlings would and do destroy, either as food or from self-protection, and in some cases from wantonness, very much of the animal life which would otherwise find a ready and acceptable subsistence upon the eggs and fry of the trout in the following year. It may be too much to state, but at least it cannot be contra-proved, that the adult trout destroys many of these enemies of their young from a sense of the necessity of the case. The yearling and the adult fish when planted in new waters in

their subsistence on its animal life, and in their fight for survival, in short, in their very living in these waters, prepare them for their progeny. It strikes me that in this they but parallel the only lines mankind has found practicable in colonizing new countries. The fact that a plant of trout fry in a particular stream, presenting outwardly all the conditions necessary for a happy trout life, has been barren of results should not be considered as conclusive argument that trout could not live and multiply in it. Try that stream again with enough yearlings sufficiently large to war upon the enemies of baby trout. And if the case is urgent, and the stream is worthy, try it with a few two or even three-year-old veterans. Take the case of the Yellowstone waters as an assurance that the fish will attend to their own multiplication and save you the trouble of annually replanting yearlings.

The relative values of fry and yearlings for stocking purposes will probably never be determined. It is certain that they both have their uses and advantages. There are times and places where fry can and will do all that is necessary for stocking a given body of water, and there are places where yearlings will be required to produce the desired result. For one, I am far from denying that very much of the magnificent result already achieved by fishculture is due to plants of fry. But, gentlemen, fry exclusively were planted when American fishculture was in its infancy; now that it has reached its majority it should stand ready to do a man's work of planting yearling fish where necessity demands, reserving its plants of fry for streams presenting favorable conditions of water and animal life. In this broad country of ours, with its diversified water systems and aquatic fauna, there are streams where fry planting will prove all sufficient, and others wherein only yearlings can succeed.

Food and cost of 28,000 rainbow trout raised at Neosho, Mo., Station, from fry to yearlings, on a mixed diet of

beef liver and mush, commencing when the fry were transferred to the outdoor pools, April 1, 1892, ending January 31, 1893:

Period.	Daily Allowance.		Total for the Month.	
	Lbs. of Liver.	Lbs. of Mush.	Lbs. of Liver.	Lbs. of Mush.
30 days of April	7.0	8.4	210.0	252.0
31 days of May	7.0	8.4	127.0	260.4
30 days of June	8.4	25.2	252.0	755.0
31 days of July	8.3	35.0	195.3	1,085.0
31 days of August	12.0	45.0	372.0	1,395.0
30 days of September	12.0	60.0	360.0	1,800.0
31 days of October	12.0	54.0	372.0	1,674.0
30 days of November	12.0	60.0	360.0	1,800.0
31 days of December	15.0	60.0	465.0	1,860.0
31 days of January	15.0	60.0	465.0	1,860.0
306 days			3,268.3	12,742.4

3,268.3 lbs. of liver, at 3½ cents a pound, cost.....$114 39
12,742.4 lbs. of mush, at ¼ cent a pound, cost..... 31 86

Cost of food for 28,000 rainbow trout, from April 1 to Jan. 31.....$146 25

Cost per 1,000, $5.22; or each fish cost a fraction over ½ cent. Average cost per day per 1,000 was 1.707 cents.

Average allowance per day per 1,000 was 1.87 lbs. of the mixture (in the proportion of 1 of liver to 3.79 of mush).

The fish were two sizes. On Feb. 11, 1893, they were measured, and weighed:

4,000 averaged 7 in. long, and 107.5 lbs. per 1,000, or 430 lbs. gross.
24,000 " 5½ " " " 42.5 " " 1,000, " 1,020 " "

28,000 yearlings weighed..... 1,452 lbs. gross.

A cost per pound of a fraction over 10 cents.

Food and cost of 12,000 "vegetarian" rainbow trout raised at Neosho (Mo.) Station, from fry to yearlings, commencing when the fry was transferred to the outdoor pools, April 1, 1892, and ending Jan. 31, 1893.

Period.	Daily Allowance.		Total for the Month.	
	Lbs. of Liver.	Lbs. of Mush.	Lbs. of Liver.	Lbs. of Mush.
30 days of April	3.0	3.6	90.0	108.0
31 days of May	3.0	3.6	93.0	111.6
30 days of June	3.6	10.8	108.0	324.0
31 days of July	2.7	15.0	83.7	465.0
31 days of August	....	45.0	....	1,395.0
30 days of September	....	45.0	....	1,350.0
31 days of October	....	45.0	....	1,395.0
30 days of November	...	45.0	....	1,350.0
31 days of December	....	45.0	....	1,395.0
31 days of January	....	45.0	....	1,395.0
306 days	.....	.....	374.7	9,288.6

374.7 lbs. of liver, at 3½ cents a pound, cost.....$13 11
9,288.6 lbs. of mush, at ¼ cent a pound, cost..... 23 22

Cost of food for 12,000 rainbow trout, from April 1, to Jan. 31.....$36 33

Cost per 1,000 $3.03; or each fish cost a fraction under ⅓ cent. February 11, 1893, they were measured and weighed: 12,000 averaged 4 in. long, and 27.5 lbs. per 1,000, or 330 lbs. gross. A cost per pound of about 11 cents.

NEOSHO STATION, FEBRUARY 11, 1893.

Measure and weight of yearling rainbow trout.

100 of the largest, mush and liver fed, 10.75 lbs .....7 in. long.
100 medium size, " " " " 4.25 lbs.....5.5 in. long.
100 of those fed on mush only 2.75 lbs.....4 in. long.

NEOSHO STATION, FEBRUARY 11, 1893.

Measure and weight of yearling brook trout.

100 average size, fed on mush and liver, 7.5 lbs.....6.5 in. long.

NEOSHO STATION, JUNE 5, 1893.

Size and allowance of three-year-old rainbow trout.

1,000 three-year-old trout in Pond No. 1 are supported in perfect condition on 2 lbs. of liver and 40 lbs. of mush per day.

10 of the largest weigh.....17.5 lbs.
15 of the medium weigh.....19.5 lbs.

25 of the three-year-olds weigh.....37.0 lbs.

or each fish 23.68 oz., making the weight of the 1,000, 1,480 lbs. The allowance per day is less than 3% of their weight of the mixture (in proportion of 1 of liver to 20 of mush), costing now 19 cents per day.

FEEDING AND GROWTH OF RAINBOW TROUT IN THEIR SECOND YEAR.

February 20, 1893, counted 1,500 13-months-old extra select rainbow trout into Pond No. 2 to be raised for future brood stock. Total weight, 140.5 lbs., an average of 93.67 lbs. per 1,000. Average length of trout, 7 in.

April 26, 1893 (65 days afterward), these trout were reweighed and found to average 260 lbs. per 1,000, and to measure from 8 to 9 in., being an increase in weight of 178 per cent. During these 65 days they had been given 185 lbs. of liver and 1,008 lbs. of mush, costing $9.29, or each pound of trout gained (after February 20) cost a fraction over $3\frac{3}{5}$ cents.

May 20, 1893, 90 days after the fish were first put into No. 2 Pond, they were again reweighed and found to average 320 lbs. to the 1,000 fish, and to run from 9 to $9\frac{1}{2}$ in. long, being an increase in weight of about 241 per cent. During these 90 days they had been given 305 lbs. of liver and 1,627 lbs. of mush, costing $17.01; or each pound of trout gained (after February 20) cost a fraction over 5 cents.

N. B.—Prior to April 1, 1893, liver cost $3\frac{1}{2}$ cents a pound, after that the price was $4\frac{1}{2}$ cents a pound. The cost of mush remained unchanged, namely, one-quarter of a cent a pound.

Up to the time these fish were transferred to Pond No. 2, they had been all the time in a pool 8 x 22 ft., among a lot of 6,000 other yearlings. The element of range, so essential to the growth of fish, was entirely lacking, as was also that of space and natural pasturage. Pond No. 2, into which they were transferred, supplied to a certain extent these requisites. It has a water surface of about 6,000 square feet and a greatest depth of 36 in. Whereas the pools had a greatest depth of only 2 ft., wooden sides and bottom, and with a constant change of 55 gallons of water per minute, the maintenance of pasture under these condi-

tions being impossible. Pond No. 2 is, for at least one-quarter of its area, less than 6 in. in depth, containing considerable aquatic flora and breeding no little natural food.

NEOSHO, MO., JAN. 25, 1892.

Specimens of trout shipped from Neosho to Washington, D. C., Jan. 25, 1892, to be cast for the World's Fair.

No. 1. Male fish, rainbow trout, hatched from eggs received from Wytheville Station in January, 1890. Weight, 30 oz.; age, 2 years.

No. 2. Same as No. 1. Weight, 21 oz.

No. 3. Brook trout, hatched from eggs received from Northville Station, January 25, 1891. Weight, 6 oz.; age, 12 months.

No. 4. Same as No. 3. Weight, 6.5 oz.

No. 5. Von Behr trout (*S. fario*), hatched from eggs received from Northville Station February 5, 1891. Weight, 3.5 oz.; age, 11 months.

No. 6. Same as No. 5. Weight, 3.5 oz.

No. 7. Rainbow trout, hatched from eggs received from Wytheville Station, January 17, 1891. Weight, 3 oz.; age, 12 months.

No. 8. Same as No. 7. Weight, 1.5 oz.

DISCUSSION UPON MR. PAGE'S PAPER.

MR. MATHER—I did not take any notes during the reading of Mr. Page's paper, except some mental ones. I rather expected to hear from Mr. Clark upon this subject, and I wanted him to get up and say something. Dr. Cary said that there would be no fun unless Mr. Clark and I had our little sparring match.

One thing, however, occurred to me during the reading of the paper, and that was, that if we stock a stream with yearlings and those yearlings breed in that stream, and their fry succeed in making a living of it, why would not the fry which might be introduced from the hatcheries

live there just as well? If fry will not live in that stream, that are artificially hatched, why should they live when they are the offspring of those yearling fish?

They are claiming a great deal of success in planting yearlings, although it has not been a great many years yet since that theory was sprung upon us. At our last meeting, when I read my paper, there was considerable discussion upon it, and four or five gentlemen took ground against me, stating there was no need of planting fry, for instance, Mr. Roland Redmond. He said one thing in favor of the yearlings was that you didn't have to transport them; all you had to do was to open the gate and let them swim out. But suppose we take the State of New York, which has considerable territory, and suppose we attempt to raise our fry to a yearling age—and Mr. Page has skipped the transportation question entirely—and we send off men one hundred and fifty to two hundred miles with fish, fifty trout in each can. If we send them with yearlings, it will depend upon the size of your yearlings whether there are twenty or thirty or more in a can, and they could only take at most three hundred of those yearling fish; and it would cost about all the money the New York Fish Commission has got to transport her trout if they raised them to be yearlings.

Here is a letter that was written to me last summer that bears upon this subject. It is from Raymond E. Wilson, Secretary of the Board of Fish Commissioners of the State of California. I had had some correspondence with him before upon the same subject, and this is his letter:

BOARD OF FISH COMMISSIONERS FOR THE
STATE OF CALIFORNIA.
SAN FRANCISCO, CAL., July 28, 1892.

MR. FRED MATHER,
Cold Spring Harbor, Suffolk Co., New York:

MY DEAR SIR: I beg to acknowledge yours of the 22d inst., and thank you for the same.

I am aware of the fact that the United States Fish Commission are advo-

cating the planting of yearling trout. We have not made the attempt, and cannot do it. Our regular appropriation in our hatchery fund is only $5,000 annually. This amount is probably swelled during the year by about $1,500 from fines and licenses. Out of this fund we hatch and distribute yearly nearly or quite 3,000,000 salmon, which takes about one-half of the fund.

The expense of distribution with us is a serious matter, as nearly all of our planting has to be done at a considerable distance from points on railroad. For illustration, we start this week with one shipment of say 25,000 fish for a point on the east side of the Sierras, distant some eighteen hours by rail from hatchery, and then between fifty and sixty miles by wagon. I do not hesitate to say that on the score of expense the planting of yearling fish in our State is impracticable and wholly out of the question. This spring we made an ex periment with the *fontinalis*, and kept them until they were five months old before planting. We will not do it again, as we cannot afford it, and, besides, the planting of the older fish was not as successful as that of the younger. We have now commenced the distribution of our rainbow. They are three months old, and plenty large enough.

The Fish Commissioner of Nevada, Hon. Geo. T. Mills, is the only one whom I have heard of who has made a success of raising and planting yearlings, but he does this under most extraordinary favorable circumstances. His hatchery is located in Carson City, perhaps five or six blocks from the railroad depot. When his fish are say three months old, he transports them by rail to the Truckee River and plants them in a large pond formerly used as an ice pond, having direct communication with the river. Here he keeps them for a year, feeding them in the meantime, and when the time comes he opens connection with the river, and the fish distribute themselves. He does the same with the land-locked salmon. To a certain extent, we are doing the same thing this year with our salmon. We have made a large nursery pond at our Sisson Station, which has connection with tributaries of the Sacramento. We keep them until the ice begins to form, and then let them out into the stream. To undertake to raise and plant yearling fish in any other manner would require a very much larger appropriation than we have.

Yours very truly,

RAMON E. WILSON,
Secretary.

During the reading of the letter, Mr. Clark interrupted the reading, saying:

MR. CLARK—Let me break in here. Let me say right there that I was the father of this idea, and not the Commissioner, and don't say he orders it.

MR. MATHER—You recommend it, he orders it. I know it was your first suggestion. I thought I would get him up after a while.

Mr. Mather then finished the reading of the letter.

Mr. Mather—There were several things I desired to say, but I will leave them until after we hear Mr. Clark.

Mr. Clark—In the discussion of this question, I hope one thing will not be done—don't let us be too personal. This is a question, as I said last year and two years ago, that I consider vital to fishculture, the question of planting fish right. That to-day, in my mind, is all there is to learn in fishculture. The matter of getting eggs and hatching them is a thing that is just as simple in practice as the manufacture of skirts.

Our worthy President to-day touched upon a subject that is very important, the question of the food of the fishes. It is one of the very important questions. The planting of fish, not only in the right place where the food is, but the question of planting as near as you can the right kind of fish for the water, is equally important.

The writer of the letter which Mr. Mather has just read states that their Commission cannot raise yearlings, but he also tells us what they are doing in that line. They have their nursery where they keep them until a year old, and then let them run into streams; and that is what I have been advocating for a number of years. We raise them at our hatcheries because we have to do it. If it were possible to do it in every instance, and you had a nursery at the head of every stream you stock, it would be better to have it right there. We have one instance of this kind of work in Michigan, where they have commenced just such an enterprise, and Commissioners Post and Whitaker have visited it, and know that what I say is the fact. They have a little nursery, and they propose to plant their fry there where they feed upon natural food. This is just what I have been advocating all along—protect your fry. I don't mean to hatch five million trout fry in this way, because it is impossible to do it unless you have lots of money. At Northville we handle four million trout

eggs, but we don't undertake to raise four million fry, but I do raise two or three hundred thousand fry to be yearlings. I am really glad that gentlemen take these things up and discuss them. But the point is to protect your fish. You take one hundred thousand fry and plant them in a stream, put them right in where there are other fish, and a great many of them will be eaten up. That we know. Of course, if you plant fry as Michigan, Wisconsin and New York have done, you are doing a great work. I have never said that these States have not done a great work in planting trout fry, because they have. I brought here last night evidences of what the Michigan Fish Commission have done, both in rainbow trout and other fish; but I hope they will never put a trout in a grayling river in the State of Michigan or in any other State. Now, what I say is this. Protect the fry and keep them from the other fishes by raising them at the hatcheries, if that is the best you can do, or by having rearing pools at the head of the stream or wherever you can.

Mr. Mather—We will fight it out fairly now. This letter says, "Speaking of * * * * to a certain extent we are doing the same this year." But he does not have to transport them, he hatches them right there.

Mr. Clark—Yes, but he could transport the fry all right.

Mr. Mather—Mr. Clark and Mr. Page have skipped the question of transportation. Mr. Page did not touch at all on the transportation of the fish. It is going to take a great deal of money to do it, and a great deal of the time of the men to do it, and I believe you can hatch fish in quantities large enough to overcome all casualties by death, and I say just put them in in plenty, and at a small cost comparatively.

Mr. Page raised the question of who would take care of these fish. Well, the Lord provides for their care if there is any food in your streams, and they will scatter and find

it. If there is no food, it is not a proper stream to stock.

Another point that Mr. Page quoted, I think from Mr. Livingstone Stone, that there was no need of loss of any account in trout fry. All of us who have had very much to do with brook trout fry for any number of years have seen in a batch of trout eggs some little fellows that will just break the egg to die; others will hatch and carry along until the time comes to take food, and then they die because they cannot assimilate the artificial food. I do not think a man can take one hundred thousand trout eggs and raise one hundred thousand trout out of them. If you have a certain number of eggs of chickens, or calves or babies, you are going to lose some of them sure.

Mr. Page—I think I could not have made myself very clear, when he says I didn't touch the question of expense at all.

Mr. Mather—The question of transportation.

Mr. Page—All these questions of expense in this work, where it is done by the State or Government, are questions that I don't think cut any figure in the question under discussion, so far as you or I are concerned. They are matters of consideration for our superior officers and the legislatures who order us to do the work.

But I did touch upon the question of transportation when I told you that if your trout fry were distributed under the best conditions, with a full knowledge of our streams, your expense of distributing fry would approximate the expense of distributing yearlings. You are mistaken if you think that was the case. But the trouble is that the fry take up a fixed abode; they huddle up in one place, and they stay there for three or four months, just waiting for a snake to come along and take them in. One other point. Did I understand you that only twenty or thirty yearlings could be carried in a can on an average in the transportation season?

Mr. Mather—If you are going any distance.

Mr. Page—We are averaging of yearlings, twelve months old fish, and we raise them as large as anybody in the world, from sixty to one hundred fish in the ordinary round can——

Mr. Mather—How many gallons?

Mr. Page—That same old can.

Mr. Mather—How far do you carry them?

Mr. Page—Some up in Minnesota and some away South.

Mr. Clark—I will say that I took 1,060 year old lake trout to Washington, and they were in ten cans, and I landed them in Washington with just 1,010 fish; and they were carried in an old-fashioned baggage car. The matter of expense in transportation, it seems to me, to-day with most of the State Commissions, as well as with the United States Commission, as they are carried in our cars, is very slight. We receive free transportation over most of the railroads, and I don't think that should be taken very much into consideration.

I think your letter from California stated that they had five thousand dollars for their hatchery. Now, you take the most of your State hatcheries, and suppose you don't have but five thousand dollars for your hatchery, and you handle from two to four millions of eggs, and that includes your superintendent's salary—that is about the way they run. The superintendent can with that much money raise from 175,000 to 200,000 yearlings, in addition to his regular trout work. I have got the figures to show that, too.

Mr. Post—I have been very much interested in the paper of Mr. Page, and it has thrown some light upon the subject, probably, of the better way of feeding and raising fry to yearlings. It is very interesting in that respect, and is the result of actual experiment, which ought to be correct.

The aspect which the case now assumes, however, is quite a different one from what it appeared to be two years ago and a year ago. Then it was yearlings versus fry,

now it seems to be a combination of the two. That is quite a different thing. Of course, those of us who have known, and that, of course, includes all who have had anything to do with the work of the different States, of the remarkable success in all the States of the planting of the fry of the brook trout, would resent the idea of giving up the planting of fry and taking up the planting of yearlings in their place, because it would be putting something in the way of experiment in the place of success. Now that is not advocated by either of the gentlemen to-day, and probably we will get around finally on to ground where we can all agree. The idea of raising two or three hundred thousand yearlings out of two or three million fry is not a question of fry versus fingerlings ; it is a matter simply of diverting a part of your fund for raising or hatching fry into the transportation of yearlings.

It may be that there is a great deal of truth about what Mr. Page has said about there being places where yearlings will do better than fry, but the problem of cost confronts every one of the State Commissioners, which Mr. Page says they leave to their superior officer, and which he says we should leave to the Legislature. We go to the Legislature to get all the money from the Legislature we can. The problem with us is how to spend that money to get the greatest results. If with the small appropriations we get we are going to get the very best result from fry planting, and our work shows it, we shall be able to get from our Legislature larger and larger appropriations to increase the work we can do. So, when it came to be discussed heretofore whether we should change from old methods which had produced great results from small expenditures to a thing which was an experiment, we were taken by surprise. But the question as it has been discussed to-day is quite a different thing.

Mr. Clark—I don't know but I am on my feet more than I am entitled to be, but that is just the shape of the

thing. That is where it should have started in two or three years ago. You will not find me quoted, neither in any paper, nor in any argument, nor anywhere else, as advocating the stopping of the planting of fry entirely and going to raise yearlings—not at all.

Mr. Page—Me too, please.

Mr. Clark—I have never advocated it at all, because the United States Fish Commission is not doing it anywhere, and the point is right there. We are to-day beginning to understand ourselves, as Mr. Post has stated. I never presented a paper on Fingerlings versus Fry, and I don't think our worthy Secretary will find the original headed in any such way.

Mr. Post—It got into the report that way.

Mr. Clark—And I want it understood that I have advocated the rearing of fish and the planting of larger fish, in a measure, instead of all fry.

Secretary—The title of your paper was "Rearing Fish for Distribution."

Mr. Vincent—Mr. President, I am trying to get something out of this discussion to-day. It is new to me largely. The State of Ohio, which I represent, has been hatching fish largely for years, but it has been mainly for the lakes, and we are endeavoring now to get them into the small streams of the State. The question of the transportation of these fish after they were yearlings was spoken of by the gentleman who just took his seat. I will say that in our State we have largely free transportation, but it does not seem to me that that factor need to come into it very largely. We have to distribute the fry in that manner, but if the plan is more practical is what I want to know, to rear your fish for a time in intermediate waters; that is what I want to find out. We can have those intermediate points on the streams we wish to stock, and we have already undertaken to establish one or two of those

places ; and if that is the case, the matter of transportation will not come in.

Mr. Post—How would you do with two or three thousand streams ? Would you have points on all of them ?

Mr. Vincent—As I understand, the fish will distribute themselves over a large area if they have the opportunity. We perhaps have five or six rivers which reach the Ohio River, and their tributaries taking in perhaps two-thirds of the State, the Scioto, the Hocking, the Muskingum and the Little Muskingum, which reach up to within thirty miles of the lake. The question I want to get at is whether it is more practical to turn the fish into the rivers after six months of age or to put them in when they are fry.

Mr. Mather—I would just like to ask Mr. Clark one little question; that is, if it is better to plant your fish as yearlings, why do you not advocate the planting of them all as yearlings, if that is the best plan ?

Mr. Clark—One great trouble with that is that if you undertook to raise five millions of fish, it would be a very great expense.

Mr. Mather—That is the point.

Mr. Clark—Now hold on, hold on; but we can raise from two to four hundred thousand at a hatchery with a very slight additional expense. Why ? Because you are going on with your regular work, and you have to have your regular men, and your regular men can do this work of caring for the fish during the fry stage. You take five million, and, of course, you have to hire some additional help, and you have to be to some additional expense; but it may be, in the course of human events, after we get this question around, as it comes around now, that we will advocate the raising of them all. Of course, that would be quite an additional expense. Of course, in regard to the yearling question, our arguments have all been on trout. Now, I advocate the handling and rearing of whitefish in the same manner. Have a rearing

pond at some good point; for instance, in Michigan we might get near some good lake which we think would be adapted to them, and have our nursery and keep those fish by themselves, where no enemies could take them, and then let them out in the lake afterwards.

Mr. PAGE—Upon the tendency young trout have to settle in one place after being planted, I want to say they don't scatter or roam about in search of food for a considerable length of time after they have absorbed their food sac. They huddle up in one spot, and any one knows who has paid any attention to it that their enemies are legion. I would be afraid to state now from memory how many snakes, destructive birds, lizards, etc., we have killed at Neosho Station; but we killed in three months last fall twenty-five hundred pounds of crayfish; and as for snakes, I killed one day in a pool a snake, and when opened we found he had taken twenty young brook trout.

STATISTICAL REVIEW OF FISHCULTURE IN EUROPE AND NORTH AMERICA.

BY N. BORODINE,

Delegate of the Russian Association of Pisciculture and Fisheries.

International exhibitions give a good opportunity to reckon up the work done in different branches of human activity, and I thought it opportune to do the same thing with regard to the most recent industry—fishculture.

During the last two years I have made a special study of fishculture outside of my country, and visited many hatcheries of importance in Europe and North America. I was thus enabled to collect some material, which is summarized in the following short review. The figures of North America were taken from the reports of the United States Fish Commission, State Fish Commissions, annual reports of the Ministry of Marine and Fisheries of the Dominion of Canada, and from the report of the Superintendent of Fisheries of Newfoundland. Those reports, regularly issued, are uniform, but they do not include any information about private fish hatcheries. For Europe, the figures have been taken from scattered information in special literature, from official information furnished by the respective Governments, and private information from the proprietors of fish hatcheries which I visited personally.

I do not consider the following figures as absolutely exact; on the contrary, I am sure that one of them, for want of regular reports, are less than reality. Nevertheless, I believe that a review of figures already known upon this matter may have some interest. Concluding these introductory remarks, I ought to say that I do not deal in this paper with pond culture, the only object of comparison being the hatching of fish in the establishments specially constructed for that purpose.

The following table gives an idea of the number of fish

hatched (in one season) in different countries of North America and Europe, indicating the date of information, the number of fish hatcheries and the expenses of the Government for fishculture :

NORTH AMERICA.	Date of information.	Number of fish hatcheries.	Number of fish hatched, millions.	Annual appropriation for fishculture.
United States :				
State fish hatcheries	1882–92	46	416.	$174,040.00
U. S. Fish Commission	1891–92	20	491.2	150,000.00
Total U. S.		66	907.2	$324,040.00
Dominion of Canada	1890–91	13	128.	39,496.50
Newfoundland	1890–91	1	581.	6,100.00
Total N. A.		80	1,616.2	$369,636.50
EUROPE.				
Norway	1890	58	214.5	4,166.50
Germany	1891	90	25.5	21,815.00
Switzerland	1890	84	13.7	2,207.00
Great Britain	1891	16	8.6	.....
Sweden	1891	34	5.4	.....
France	1891	17	4.2	3,960.00
Austria-Hungary	1891	96	2.8	.....
Italy	1891	5	1.1	.....
Netherlands	1891	2	1.	2,084.00
Russia	1891	14	1.	2,800.00
Total of Europe		416	277.8	$37,032.50
Grand total	1891	496	1,894.	$406,669.00

The most of the figures relate to 1891, so that we are able to consider the grand total for this year. On the other hand, all the principal countries being included in the table, we may estimate this total as representing the figures of fishculture in the entire world. Four hundred and ninety-six fish hatcheries are registered in this record, 416 of them in Europe and 80 in this country.

The fish hatcheries of North America, included in the table, belong, without exception, to the respective Governments.

Most of the European fish hatcheries are private establishments, and only 82 out of 416 are controlled by their respective Governments, viz., 14 in Switzerland, 1 in Germany, 5 in France, 2 in Italy, 58 in Norway, 1 in Great Britain and 1 in Russia.

The totals of fish hatched in North America (1,616,027,192) as compared with Europe (277,973,016) show that only about 14 per cent. are produced in Europe; among European countries, only Norway, thanks to the active part taken by its Government, can be considered as a serious competitor of the countries of the new world. The average production of one fish hatchery is 668 thousands in Europe and 13.4 millions in North America. Such a striking difference of the new world depends principally upon the difference in the character of the hatcheries of both continents. As before mentioned, the European fish hatcheries being private establishments, do not pursue the task of restocking public streams, but only the streams belonging to the proprietors, and very often they produce fry for sale to other proprietors of fish ponds, etc. Another circumstance to be mentioned in connection with the small size of European establishments is that no hatcheries—or very few—exist here for hatching of *Clupeidæ*, *Percidæ* and salt water fish; the hatching of these kinds of fish, to be successful, ought to be carried on on a large scale. The last and the most important question is the financial one. While the Government of the United States, of different States, of the Dominion of Canada, grant very considerable amounts of money for fishculture, and take direct interest in this work, in Europe, with the exception of Norway, Germany and Switzerland, the respective Governments do not pay much attention to it.

The Government of the United States has a very important bureau, known as the United States Fish Commission, with annual appropriations of $298,000, viz.: $150,000 for propagation of fish, $50,000 for distribution, $53,000 for

maintaining vessels, $5,000 compensation of Commissioner, and $20,000 for scientific investigations and statistical work. Besides this regular budget, the United States Fish Commission receives for extraordinary expenses, as, for instance, the construction of new hatcheries, new vessels, fish cars, etc., a considerable amount of money.

The Governments of separate States compete in usefulness of this work with the Federal Government, making large appropriations for building hatcheries and distributing fish. I must particularly mention the State of New York, with a yearly appropriation of $34,000, the State of Michigan, with an appropriation of $22,500, and the State of Pennsylvania, with a grant of $15,000. The total amount of money granted for fishcultural work by all the States is equal to $169,040 (1891).* The present appropriations are likely to be increased, because in very many reports I have examined, the Fish Commissioners were asking for a larger amount of money.

The Government of the Dominion of Canada has been for a long time actively engaged in the propagation of fish. The expenditure for this work was in 1891 $374,202, which includes $39,496 for fish breeding and $83,050 for fish propagation.

The Newfoundland Government works also quite successfully with an appropriation of $17,300, that is, $6,100 for fishculture and the remainder for fish propagation and fishery administration.

In Europe, Germany expends the largest amount of money for fishculture work, say $21,815, which includes $12,500 of subsidy to the Deutsche Fischerei Verein, the leading association of its kind in Europe, and $9,315 for the Government fish hatchery in Hüningen. Many private hatcheries exist in that country, thanks to the orders for hatched fry given by the above association, which has no

* General expenses of same States for fish protection and carp culture are not included in this total.

hatchery of its own. The Hüningen fish hatchery—perhaps the largest on the continent—has no value from the standpoint of the modern fishculturist, and with regard to the accommodation for the work, many private establishments* in Germany leave far behind this big, but inconvenient, old-fashioned hatchery, which, I think, has completed its historical role in fishculture. Norway is now one of the leading countries in regard to the work for all kinds of improvements in fisheries. Its Government grants for this purpose an amount of $57,788 yearly, which includes $41,665 for fishculture in particular.† One of the largest salt-water fish hatcheries in the world, at Flodevigen, near Arendal (200,000,000 cod fry hatched in 1891), is controlled by a local fishery association, and gets a subsidy of 9,000 kroners from the Government. Next comes Switzerland, which operates, as compared with its area, on a very large scale. The Federal Government of that country has an appropriation of $2,207 for the fry planted by private men in the public waters. Besides that, almost every canton has one, two and sometimes several cantonal fish hatcheries.

France—the cradle of pisciculture, the country which has contributed toward the development of this new industry more work than any other country—now ranks far behind many European countries. The French Government does not pay much attention to fishculture in general, having an appropriation of 19,860 francs ($3,972) to maintain five not very large governmental fish hatcheries, and subsidize a private one (for shad hatching at St. Pierre les Elbeuf, on the Seine River). Only quite recently, thanks to the statements made by the Société Centrale d'Aquiculture de la France, the attention of the French

*I can mention here the well-situated and nicely-fitted fish hatcheries in Selzenhof, near Freiburg (8,000,000 trout eggs capacity), and in Seewiese, near Gemunden, Bavaria (4,000,000 capacity).

†The total of 208,040kr. is thus distributed: For scientific investigation in fisheries, 5,200kr.; subsidy to the fishery associations, 45,000kr. (that includes 8,000kr. for the hatchery at Flodevigen): maintenance of fishery schools in Bergen and Bodo, 11,500kr.; fishculture work, 7,250kr.; and the remainder for fish protection and fish administration.

Government has been called to fishculture work, and I am informed that negotiations are being made to establish a special fishculturist school at the Gremaz fish hatchery, which belongs to M. Lugrin, inventor of the method of propagating artificially live food for fish fry.

Italy has only recently begun fishcultural work under the control of the Government, which has appropriated 32,000 liras ($6,500) for the construction of a large fish hatchery at Brescia, now in operation, and has opened another small one at Rome.

The Netherlands Government appropriates only 5,000 gulden ($2,084) for the salmon fry planted in the Rhine River. No appropriation is made by the Austria-Hungary Government, the fishculture work being carried on by private initiative of landlords and associations.

The same remarks must be made in regard to Great Britain, with the single exception of Scotland, the fishery board of which erected last summer a salt-water fish hatchery at Dunbar; no special appropriation was made for this purpose, the expenses having been covered by money assigned for scientific investigation (£1,800 yearly).

The Swedish Government contributes to some extent to the improvement of the fishery industries in its country, having a yearly appropriation of 47,000 kr. ($13,155), but that does not include any expense of fishculture work in particular.

And finally Russia has an appropriation of $2,800, which is, in comparison with its area, quite insignificant. That includes 3,000 roubles for maintaining one governmental fish hatchery at Nicholsk, Government of Novgorod, which was founded by the well-known Russian fishculturist, Mr. Vladimir Wrasky, the inventor of the so-called Russian or dry method of impregnation, and 5,000 Finnish marks of subsidy to the Fishery Society of Finland.

When we compare the total amount of money spent for fishculture work by all European countries ($37,032.50)

with the appropriations of North American countries ($369,636.50), we shall not be surprised by the enormous difference in the work done in this line in the Old and New World. Of course, that is only an explanation of the fact, but not an eulogy.

Europe has originated and developed the methods of fishculture, but it becomes an industry only in America, and a very important one, from the standpoint of the Government. Only here is fishculture carried on on a large industrial scale, and, in connection with it, here are invented and introduced in general practice, methods suitable for large operations, quite different from those used in Europe.

There is no better testimony of the importance of fish-cultural work than the large appropriations made by the body of representatives of the country, and only in North America is this work duly appreciated by the Government as well as most of the population.

DISCUSSION OF DR. NICHOLAS BORODINE'S PAPER.

MR. CLARK—I would like to have the Doctor tell us what they are doing in France about raising artificial food, where they state they grow the food in such enormous quantities. I understand he has been there.

DR. BORODINE—It has been a secret until now, but from what I have seen I am sure it is a very important thing.

CAPT. COLLINS—The Doctor made reference to the large number of lobsters hatched in Newfoundland, and I thought perhaps the Society might be somewhat interested in this matter as bearing upon the paper read yesterday. It may not perhaps be known by all the members of the Society that Newfoundland authorities have put in boxes at many harbors where fishermen or some person connected with their Commission obtained the eggs, and putting them in these floating boxes, leave them there to hatch

out. This accounts for what seems to be an enormous output with very small expenditures. I am personally familiar with the coast down there and know they have opportunities for doing this which are unexcelled, if they are equalled, in the world. However, the fact that they do this seems to offer a useful suggestion to those who are engaged in the propagation of marine species in the United States—a suggestion which I hope will prove profitable not alone to those engaged in fishculture, but to the fishermen themselves.

Mr. Booth—It seems to me, Mr. President, that with the consent of the Doctor, these statistics should be obtained from him and printed and kept for the benefit of this Society. To me it has been a very remarkable paper, and a very interesting one and very valuable. I would suggest, with the Doctor's consent, that we have it in the records.

The President—I will say for the information of Mr. Booth that all papers read before the Society have heretofore been printed, and this paper will follow the same course, if there is no objection on the part of the Doctor.

Capt. Collins—Mr. President, I have a paper here which has been handed to me by the Hon. Mr. Ravn, Commissioner of Norway to the Columbian Exposition, which he has requested me to read. It has been prepared for the purpose of showing something regarding the Norwegian exhibit, or rather making allusion to it, and at the same time to give a comprehensive idea, in a few words, of the extent and value of the Norwegian fisheries.

I will say, as a prefatory remark, that Norway occupies in the Fisheries Building the largest space of any foreign country, and its exhibit is perhaps more complete than that of any other country with a collection there.

I shall have much pleasure to-morrow afternoon, if I can have an opportunity, of calling the attention of the Society specifically to certain things in the Norwegian section that

I deem worthy of notice. I think it is a matter of congratulation and satisfaction to all interested in American fisheries that the Europeans have done so well in sending exhibits here. I regret to say, however, that all have not arrived yet. Germany at first declined to make an exhibit of this character, but later on its Commission decided that it would be a good thing to do, and I now understand there is a large collection on the way from Germany, which may be expected here in a few days.

SOME PLANKTON ESTIMATES IN THE GREAT LAKES.

BY J. E. REIGHARD.

In 1881, Prof. S. A. Forbes conducted at Chicago some experiments to determine the first food of the common white-fish. The details may be found in his paper,* so that it is sufficient here to recall his conclusion, that the young white-fish takes as its first food certain minute entomostraca found swimming freely in the open water (*Cyclops thomasi* and *Diaptomus sicilus*).

Forbes pointed out, moreover, the importance of determining the presence and abundance of these entomostraca in any locality in which it is proposed to plant white-fish fry. In spite of this advice, nothing appears to have been done in the ten years that have passed since the publication of Forbes's paper.

Fishculturists have annually planted millions of white-fish fry without taking the trouble to determine whether the waters in which they place them contain the necessary food in sufficient quantity. There is urgently needed an

* The First Food of the Common White-fish, Bulletin No. 6, Illinois State Laboratory of Natural History, May, 1883.

exact knowledge of the numbers of these minute crustacea in a given volume of water, over the whole area of the great lakes, and at each season of the year; and not until such determinations have been made will the fishculturist know accurately where his fry may be most advantageously planted.

In April of this year, the Michigan Fish Commission requested me to make an examination of the waters in which the white-fish fry were at that time being planted. As the planting operations had already begun, only a short time remained in which to make preparation for the work contemplated, so that it was not possible to have apparatus of precision made for the purpose.

The only entirely accurate method of determining the volume of living forms (*i. e.*, the *plankton*) contained in a given volume of water is by the use of the vertical plankton-net. This is a conical net of fine silk bolting-cloth attached to a metal ring. It is lowered to the bottom and then drawn slowly upward to the surface. The net thus strains the water in a vertical column, the base of which is equal to the size of the opening of the net, while its height is equal to the distance through which the net is drawn in raising it. Not quite the whole of this column of water is thus strained through the net, since the resistance offered by the meshes of the cloth causes about one-tenth of it to pass over the edge of the net. Whatever was contained in the column of water strained is found at the bottom of the net, and may be preserved in alcohol for future examination. After the material has been brought to the laboratory, the volume taken at each haul is measured by means of graduated glass tubes reading to tenths of a centimetre. This volume is that of all the minute animals and plants living under an area of lake surface equal to that of the opening of the net. From this it is possible to compute the volume of minute living forms to be found over any given area of water or in the entire

lake. By the use of suitable devices it is possible to count the number of individuals of any kind contained in a measured volume of this material, and from such a count we may estimate the exact number of hundreds of *Cyclops*, or of any other form contained in every cubic yard of the water. Thus we may estimate the number of individuals of any kind in an entire lake.

As there was not at hand the apparatus necessary for working with the vertical plankton-net, recourse was had to an ordinary muslin tow-net, about one foot in diameter and three feet deep. Since the quantity of material to be obtained by raising this net from the bottom to the surface was exceedingly small, serious errors were likely to be introduced into the measurements by the losses incident to emptying the net and getting the material into the preserving bottles. Instead of using the net as a vertical net, it was, therefore, towed behind the boat for a certain number of minutes and then emptied. The amount of material thus obtained was much greater than by using the net as a vertical net, and the losses incident to emptying were relatively so small that they could be neglected. The net was towed sometimes at the surface, while at other times it was weighted so that it traveled beneath the surface. When the net was out of sight beneath the surface, the angle made by the tow-line was measured with a goniometer, and from this measurement and the length of the line was calculated the distance of the net beneath the surface.

The net was usually towed behind a tug for ten minutes. Occasionally the time was twenty minutes and sometimes only five minutes, but all calculations have been reduced to a basis of ten minutes. The boat was estimated to travel at the rate of one mile per hour. For this nothing better was to be had than the statement of her captain, so that there may be a considerable error in this respect, but it is a uniform error which does not affect relative values. In

ten minutes the boat would thus have traveled 880 feet. The area of the opening of the net is 100 square inches, or .75 of a square foot. In ten minutes the net thus strained 880 x .75 = 660 cubic feet of water. Since about 10 per cent. of the water passes over the edge of the net, and not through it, we may say, in round numbers, that the net strained 600 cubic feet of water in each haul of ten minutes. The material thus collected was preserved in alcohol for future examination.

This examination showed that in every case the take consisted almost wholly of two things. First, there were immense numbers of those minute, microscopic plants, the diatoms, and besides these almost nothing but entomostraca. These entomostraca have not been studied sufficiently to determine the species to which they belong, but a glance suffices to show that they nearly all belong to the one family of *Calanidæ*, which of all our copepoda are best adapted to lead a roving life in deep water and far from shore. In this connection, it is worth while to note that the *Calanidæ* live almost altogether on diatoms and other minute algæ. These algæ, in their turn, get their nourishment from the inorganic matter in solution in the water, matter which the waves wash from the soil along the shore and which the rivers bring down through long distances. If the algæ are thus nourished by the substances in solution in the water, if the *Calanidæ* feed on algæ and the young fish on *Calanidæ*, we have a very pertinent illustration of the conversion of the constituents of the soil into fish-flesh.

After having thus determined roughly the character of the material found in each locality, that obtained at each haul of the net was placed in a graduated glass cylinder and measured.

The following table from my note book is a complete record of the work done:

NO.	LOCALITY.	DATE, 1893.	HOUR.	SKY.	WATER.	TEMPERATURE		DURATION OF TOW.	DEPTH OF NET.	DEPTH OF WATER.	VOLUME TAKEN.
						OF AIR.	OF WATER				
1.	Frankfort 1½ miles out.	Apr. 16.	10.35 A. M.	Light clouds.	Rough.	.....	....	10 m.	7.6 ft.	78 ft.	5 c.c.
2.	"	" 16.	11 A. M.	"	Rough.	.....	....	"	34.7 ft.	180 ft.	5.6 c.c.
3.	Manitou Islands.	" 17.	7 A. M.	Cloudy, wind north.	Nearly smooth.	32° F. top & bot.	48° F.	"	24.5 ft.	30–54 ft.	7.2 c.c.
4.	"	" 17.	7 A. M.	Cloudy, wind north.	Nearly smooth.	32° F.	48° F.	"	5 ft.	30–54 ft.	.3 c.c.
5.	Between Manitou and Fox Islands.	" 17.	1.45 P. M.	Clear, no wind.	Nearly smooth.	32° F.	....	"	65.1 ft.	360 ft.	4.06 c.c.
6.	"	" 17.	1.45 P. M.	Clear, no wind.	Nearly smooth.	32° F.	....	"	Near surface.	240 ft.	.5 c.c.
7.	Ludington, 2 miles out.	" 18.	4.45 P. M.	Clear.	Slight waves	34° F.	40° F.	"	10.8 ft.	60 ft.	2.1 c.c.
8.	Ludington, 1½ miles out.	" 18.	5.15 P. M.	Clear.	Slight waves	33° F.	40° F.	"	.5 ft.	.....	.4 c.c.
9.	Ludington, 4 miles out.	" 18.	6 P. M.	Clear.	Slight waves	33° F. top 34° F. bot	38° F.	"	13.5 ft.	78 ft.	3.04 c.c.
10.	"	" 18.	6.15 P. M.	Clear, sun set.	Moderate waves.	"	38° F.	"	6.75 ft.	78 ft.	1.85 c.c.
11.	Detroit River, above	" 28.	4 P. M.	Cloudy.	Nearly calm.	.....	....	"	Surface.	20 ft.	.8 c.c.
12.	Belle Isle Bridge.								10 ft.		1.2 c.c.

From this table the following facts appear:

1. That the volume taken at the top is in every case less than that taken at greater depths. Compare, for instance, Nos. 2, 3, 5 with Nos. 4, 8, 11.

A comparison of Nos. 3, 5, 6, taken in the same locality on the same day, seems to show that the volume increases to a certain depth and then again diminishes. At the surface, or a few inches below, there is only .5 c.c. for each 600 cubic feet of water; at 24 feet, there are 7.2 c.c., and at 65 feet, 4.06 c.c. for the same volume of water. This result cannot, however, be regarded as final, since it rests on but one set of observations. It is well known that many of the animals composing the plankton migrate toward the surface at night and seek greater depths during the day, and it may be that the difference between a cloudy and a sunny day produces a corresponding migration.

3. At the same depth, or about the same depth, the volume taken varies with the locality.

The observations refer to four localities:

(a) At Frankfort, Michigan, about one and a half miles from land.

(b) In the neighborhood of the Manitou and Fox Islands, between thirty and forty miles north of Frankfort.

(c) At Ludington, Mich., about fifty miles south of Frankfort, and between two and four miles from shore.

(d) The Detroit River, a few rods above Belle Isle Bridge.

The first three localities cover a stretch of about eighty miles along the east shore of Lake Michigan, near its northern end.

A comparison of the region at Frankfort and the Manitous shows that at corresponding depths there is a larger volume of plankton than at Ludington. Thus, No. 1 at Frankfort, at a depth of 7.6 feet, shows 5 c.c. per 600 cubic feet, and No. 10 at Ludington, at 6.75 feet, shows but 1.85 volumes. No. 3 at Manitou, at 24.5 feet, shows 7.2 volumes, while No. 9 at Ludington, at 13.5 feet,

shows but 3.04 volumes. In the case of No. 1, taken at 10:35 o'clock in the morning, with the sky covered with fleecy clouds, the amount of light was probably at least as great as in the case of No. 10, taken under a clear sky at sunset.

While such evidence cannot be regarded as conclusive, it is, nevertheless, the only evidence now obtainable, and seems to indicate that at Frankfort and the Manitous the plankton is at this time of year about two and one-half times as abundant as at Ludington.

Turning to the Detroit River, we find at a depth of ten feet a volume of only 1.2 c.c. per 600 cubic feet of water, an amount only one-third to one-half as great as at Ludington, and one-fifth or one-sixth as great as at Frankfort and the Manitous.

While more accurate and extended observations might modify the results for Frankfort and Ludington, this is in no way probable in the case of Detroit.

The results mean that white-fish fry would find food only from one-half to one-sixth as abundant at Detroit as at Frankfort, the Manitous or Ludington.

This is only a very imperfect sample of the work that needs to be done. The enormous interest involved in the fisheries of the great lakes and the heavy expenditures incurred in stocking the waters with white-fish and other fry, warrant a most careful and exhaustive examination of the biology of these waters. The problem should be attacked from every side and in the broadest scientific spirit. It is necessary to know accurately the kind of animals and plants inhabiting these waters, the numbers of each kind in a given volume of water, the variations in these numbers due to season, locality and other conditions. It is necessary to know the food of each kind of animal, its enemies and life history. The chemical composition of the water, the changes of temperature, at various seasons and at all depths, should be investigated. In short, every kind of

knowledge that it is possible to record concerning the life of these lakes is of importance. Not until all this has been done can fishculture in the lakes be carried on with a full knowledge of the conditions which it has to meet. The work can not be begun too soon, nor pushed too rapidly or too far.

DISCUSSION OF PROF. REIGHARD'S PAPER.

PROF. REIGHARD—I want to say a word with reference to the remarks of Dr. Borodine, regarding artificial food for and the raising of these crustacea. The process is this as described by a French writer. He takes dishes perhaps of the size of a tumbler which are filled with cow-dung, and over the top he places a net, and after awhile the diatoms, a few which may be in the water multiply in great numbers so they form a film or coating over this netting, and then any crustacea, he says, which may happen to be in the water feed upon the diatoms and multiply so he gets them in enormous numbers. He suggests the use of that method or something like it for raising this whitefish food. He suggests, for instance, the digging of ponds and the making of troughs running from the shore into ponds, and shoving from the shore baskets or tubs containg cow-dung or other inorganic matter, getting the right plants which will live on that; the plants are diatoms, the dead matter is cow-dung. If the French Government has any secret it must be in the inorganic matter with which you start.

MR. CLARK—Mr. President, I have never stated to the Society nor any one else, what I have done in this process, neither have I ever stated to any member of the U. S. Fish Commission, the Commissioner nor any one else, but I have been working on this process for six years, unbeknown to anybody. But I have failed to do the work that it is claimed they can do. I have been working on the dung process entirely, but I cannot produce the food in any

quantities such as the French people state they can raise. There has been my trouble. I have worked not only with cow-dung, but with horse dung, and I have worked with human dung, but still I cannot get those little things in the quantity I desire. I can get more than I get naturally but I cannot get a pond full that will keep ten thousand yearlings from month to month. I have been doing work according to this process for ten years, and I am about discouraged and ready to give up.

PROF. REIGHARD—These published statements don't give the number.

DR. BEAN—I would like to ask the Professors if these towings mentioned in the paper he has just read were made at any particular time of the day, or whether any difference was found in the plankton or life in the water at different times of the day or in different temperatures of water? Every person who has gone to sea knows that the food of fishes which is so evident at the surface and is known to the fishermen as "seed," "fish seed" or "cayenne," disappears at certain times of the day. At certain times in the day it is on or near the surface and at other times it is down in the water. I should think that the same thing would hold in fresh water. The plankton might be extremely abundant in one belt of water at one time of the day or at a certain temperature, and might be entirely absent at another time; therefore I would like to have the Professor state something about the conditions under which the towings were made.

PROF. REIGHARD—I have those conditions here. They are stated in the paper.

CAPT. COLLINS—Inasmuch as the planting of whitefish fry, which has been enormous, has not apparently given the results that have been anticipated or at least hoped for, I think these facts which are presented by Prof. Reighard are very interesting.

In this connection I would like to hear from the gentle-

men present who have been intimately associated with the whitefish work, as to the localities in which they are usually planted, and whether it is true that they have been put into the lakes in the deepest water, and whether they have been put in localities where they would probably find the best supply of food and the purest conditions of water.

Another thing I have noticed is that he stated that the supply of food found in the Detroit River was somewhat smaller than elsewhere. I would like to inquire if in his judgment this is due to any pollution of the river by drainage or sewerage?

Prof. Reighard—I think the determinations were made above the point where the sewers discharge their contents into the stream.

Mr. Mather—I would like to say for the information of Mr. Clark, that some ten years ago I used to go out with the captain of the good ship Hamilton Fish, and he used always to carry his microscope with him, and he worked a good deal on diatoms. He took the dung of the green turtle and he said that was the best thing to grow diatoms in that he knew of. He said I have tried many things but there is nothing to compare with it. He made the remark to me, you could grow lots of oyster food on that if you had the diatoms.

Mr. Whitaker—In answer to the question put by Capt. Collins, regarding the localities in which whitefish fry are planted, I would like to say that, having been identified for a long time with the whitefish work of the Michigan Commission, which has been quite extensive, I am entirely familiar with what has been our custom as to making plants of the fry. We have sought to govern the locality of planting by such light as we have gained from experience, and by the light of reason. We know that certain localities are selected by the parent fish in which to cast their ova, and presumably such localities are the proper ones, and are most likely to be the right places in which

to deposit the young fish. It must be presumed that the food conditions exist in such places which are most favorable to the sustaining of the life of the young fish.

Our statistical agents engaged in the collection of statistics concerning the fisheries of the State are directed to interview the fishermen at all points and to learn from them as nearly as possible the exact locality of the spawning beds, and to carefully note the same, that it may be used for future reference in making plants. This has been done, and as nearly as we can we follow this information in determining where plants shall be made.

The great difficulty concerning this matter is, that such information is to a certain degree unreliable at best, but it is the best we have at present, and is helpful to assist us in determining as nearly as possible the best localities.

In this connection I wish to say you will remember probably that this is one of the questions I have before urged which should be taken up and determined definitely. Every spawning bed of the commercial fishes of the great lakes should be fixed by investigation and by persons qualified to judge by education and training where they are, and these localities so determined should be marked upon charts for the use of the fishculturist.

THE FISHERIES EXHIBIT AT THE WORLD'S FAIR.

BY CAPT. J. W. COLLINS.

MR. PRESIDENT AND GENTLEMEN: I regret exceedingly the short notification I had of this meeting, and the amount of work which has devolved upon me immediately prior to the meeting has made it impossible for me to prepare a paper as I had hoped to do, reviewing the work and

the results connected with the fisheries exhibit at this Exposition. It will not, therefore, be practicable for me to adequately present to you those matters which I had hoped to bring to the attention of the Society.

About two years ago I had the honor of addressing the Society concerning the then proposed fisheries exhibit at the World's Fair in 1893, and viewing it from that standpoint, I had looked forward hopefully to the assembling of collections here which would adequately represent much, if not all, that relates to the fisheries of the world, including the allied industries, such as fishculture, which has come into prominence in recent years, and also the scientific efforts which have been carried on to a greater or less extent in Europe and America in connection with the study of the fisheries and their prosecution.

To say that my ideals have been realized would not be to state the whole truth. When I tell you that in my belief there is not a great Exposition building on these grounds, outside the Horticultural Building, which does not contain something which should be embraced in a fisheries exposition, if it was such pure and simple, you can realize how difficult it has been to draw from those exhibits and to bring together under the roof of the Fisheries Building the things which are now there assembled. In the Agricultural Building you will find fishery products. In Machinery Hall it naturally follows that there are many devices, engines, etc., that are used in connection with fishing vessels or with the fisheries in some other way. In the Manufactures Building are any number of important and beautiful exhibits which would be included under the head of fisheries if this were a fisheries exposition alone. Even in the Mines and Mining Building there is a beautiful exhibit of pearls from Wisconsin, which has been taken there because somebody thought the taking of pearls was mining. In the Transportation Building are many forms of fishing exhibits from various parts of the world

which go to fill in the missing link, so to speak, in lines of transportation, and even in the Arts Building a very considerable percentage of the beautiful paintings that are there, might properly be included under the head of a fisheries exhibit.

I think it is but just to myself to make allusion to these facts which I have mentioned in order; if there are any missing links in the Fisheries Building, they may thus be accounted for. I have not in this enumeration included the exhibit of the United States Fish Commission which stands close to that in the Fisheries Building, for the reason that I have always looked upon that, and I think it has generally been looked upon, as a part of the general fisheries display at this Exposition, and was so intended to be from the first, though it was deemed expedient and best for all concerned that it should be put in the Government Building to be distinctly a national exhibit, an exhibit which would be systematically arranged and would cover in a general way all that relates to the fisheries of this country, as well as to fishculture and scientific exploration as conducted by the national Government.

But, notwithstanding all this, there is reason for some satisfaction in what has been accomplished by the department. It is true that there has been delay in the installation, due to the fact chiefly that certain of our State Legislatures were tardy in making their appropriations, that some individuals did not realize the importance of this Exposition to themselves until near the date of the opening, and to the additional fact that the exhibit from Russia was delayed by being frozen in in the Baltic, and to the fact that those from Brazil have not arrived so early as expected because of some difficulty in getting them shipped from that country. To-day, however, the exhibits are practically completed, and I have much satisfaction in saying that at my request special effort has been made to place in position the exhibits from Russia and Brazil in

order that this Society might examine those collections. They are now nearly ready or in a very advanced stage.

I do not deem it necessary to go over these exhibits in detail to this Society. I believe the most of you gentlemen have had the opportunity of looking at the exhibits and have formed your own opinions regarding them. It may be well, nevertheless, to say in general terms that the exhibits fill the classification as it stands. This classification will embrace subjects of scientific inquiry as well as of fishculture; also the maps showing the fishing grounds and the distribution of species. Following these, it was intended to illustrate the laws and other literature of sea fishing and angling, also to show pictures, emblems and various other things connected therewith. Then we come to the fresh-water fishing and angling, which covers all the various appliances and methods used either for sport fishing or commercial fishing in the great lakes or other interior waters. Following this was a group which embraced the whole subject of the preparation of the fishery products and the products themselves, and last, one including fishculture and scientific study of the matters relating thereto. In various ways the first group has been very completely filled. Not only have we live fish and other forms of aquatic life in the main aquarial building and in the exhibits from Pennsylvania and Wisconsin, but there are innumerable varieties of fish and other animals which are pursued by fishermen, appearing as mounted specimens in casts and represented by paintings and photographs and otherwise. The fishing grounds are also illustrated by certain exhibitors. It is hardly necessary, I believe, to say to any one who has visited the Fisheries Building that the gear of all countries, the apparatus used for capture, is well represented.

A very interesting collection to me is that of the fishing craft, vessels and boats. Not only can we see the rude dug-outs, skin boats and bark canoes which were in use in

this country at the time Columbus discovered this continent, but we also have before us representations of fishing vessels and fishing boats from nearly all countries that are commercially interested in fishing. I deem it a matter for special congratulation that Russia has sent here the largest collection of fishing vessels which I believe she has ever sent anywhere, and Brazil has many things which are unique and interesting, though they are primitive.

As to products and methods of preparation, they are quite as numerously illustrated as the fishing gear. The only thing I have discovered that is wrong in connection with the exhibit is that some visitors entering the Fisheries Building mistake the odor of sea birds and fish for that of nets, lines, etc., and it is not uncommon to see noses put up when they enter the building.

Fishculture is illustrated by some of the States, Pennsylvania and Wisconsin particularly, which not only show representations of the hatcheries, but place before the public the results of the work which has been accomplished by propagation.

Norway, too, has sent models and drawings of her hatcheries and specimens of the apparatus used in fishculture in that country. In the Government Building the United States Commission has a more complete exhibit in this direction, I believe, than has ever been brought together previously, and the actual propagation of fish artificially has been carried on since the opening of the Exposition.

It will be seen, therefore, that the fisheries exhibit, taken as a whole, pretty nearly fills the bill; and though it may not realize all that some of us hoped for, while it may not come up to that ideal which might be fixed, I believe it will prove one of the most instructive object lessons to be found at this Exposition. The importance of this exhibit from an educational standpoint is beyond computation. I have seen children stand with the utmost interest making

inquiries about the live fish, the fishing boats, and I don't know which has the greater attraction for them. I believe all of you realize what an attractive thing a finely rigged model is to a boy. I have been surprised at the intelligence shown by some of the school children in regard to these objects. But it is not alone this fact that makes this exhibit of consequence to us. This is the first fish exposition, if I may be permitted to use the term, that has ever been held in this country, and it is the first opportunity which those engaged in the fisheries and fishculture have had to bring to the attention of the millions of our citizens the subjects in which they are interested, in such a way as to leave a lasting impression. How important that is I need not say. I believe there is no person who does not fully appreciate it. Many of you have been giving the best years of your lives to the work intended to maintain the abundance of fish in our streams, and thereby to improve our fisheries; but you might be surprised if you realized how little comparatively is known of this by the public at large, and how few of our people who are directly dependent for a livelihood appreciate it to its full extent. If, therefore, this exhibit of the fisheries, of fish and fishculture at this great World's Fair tends to improve the knowledge of our people in matters relating to these subjects, then the labor, worry and anxiety which have attended the assembling of these collections and the getting of them into place will not have been in vain. I hope, also, it will be possible for many of our people who are engaged in the commercial fisheries to come here and study the collections which have been so generously brought to this Exposition by the distant countries of the earth. Though we have made many advances in fisheries in the United States, as in other industries, it certainly is not safe for us to assume that we know it all. There may be useful lessons to be learned by making a critical examination of the objects which have been brought here. I was

both pleased and surprised when the exhibit from Norway was being installed to find there was a product consisting of the tanned skin of a fish, one of the commonest fishes we have on the Atlantic coast, which is beautiful, and which we had never thought of utilizing. I observe that Russia also has the same thing, together with various things made of this skin. I refer to the skin of the common wall-fish, as it is called in New England, catfish.

In the department of angling, I think there is much which will interest the disciples of Izaak Walton. I deem it especially appropriate, too, that the gentlemen interested in fishing for sport and in gaining that specially pleasing recreation which can be found only on streams and ponds and lakes and ocean, will see immediately in front of the cases containing rods, reels, flies and the other paraphernalia in which they delight, what the fishculturist is doing to fill the streams and make it possible for the present and future generations to gain health in trying to reduce the numbers of fish in our waters.

This morning we had a very interesting paper from Dr. Borodine showing graphically the relative importance of fishculture as carried on by this and other countries. Those figures speak for themselves, and it needs no words of mine to emphasize them. I may, nevertheless, be pardoned for expressing my feelings on the importance of this work as bearing upon the success of our commercial fisheries and the health and well-being of those thousands who only seek recreation and relief from exhausting work on the banks of our interior waters or along our coast line. To-day we have a large country, sparsely settled in certain sections, but, nevertheless, it is apparent to all of you gentlemen who have been connected with this work that there is danger of depletion of those species of fish which inhabit our interior waters. Our population is increasing at a phenomenal rate, and the day is not far distant when the food of the future man will depend largely

upon the success of the fishculturist; and he will have to thank those of you who are now engaged in this work for laying the foundation sof your work so broad as you have, and for throwing so much effort into the work as you have. Personally, I think the fishermen and the public at large will grow to appreciate this as the years pass by, and if, as I hope, they will join heartily in the work of co-operation, much can be accomplished which now seems impossible.

THE ANGLING EXHIBIT AT THE WORLD'S FAIR.

BY DR. JAMES A. HENSHALL.

Mr. President and Members of the American Fisheries Society: As the time is very short, and I speak entirely without preparation, I shall detain you but a moment. Perhaps it would be better were I not to detain you at all, as it is intimated President Harrison is to be here soon.

However, I will state in as few words as possible some of the matters of interest connected with the angling exhibit, drawing your attention to some few things that I would like you to see when you visit it.

The western annex, called the Angling Pavilion, was originally intended to be filled with angling tools and utensils and accessories, but last fall it was thought desirable to give up a part of the room to State exhibits. At present, therefore, only about one-half of the building is occupied by anglers' appliances. I can hardly hope to interest the members of this Society in matters relating solely to angling.

While the exhibit is a small one, it is a very characteristic exhibit of angling goods which are manufactured to-

day, and while it fills the bill, as Capt. Collins has just remarked, it does not fill the building.

In the first place, there is a collection of split-bamboo rods which I believe is the finest collection in the world. And they are practical rods, running in price from $25 to $75, although there are some which, by the addition of gold and silver, will run up possibly to $400 or $500. I desire to specially call your attention to two rods made by the inventor of the split-bamboo rod. Of course, every gentleman here understands the nature of split-bamboo rods. This rod was invented by an old trout fisherman of eastern Pennsylvania, an old gunsmith, who used to fish every Saturday of his life, after he was old enough, and who was a very excellent and fine workman. He used to spend his hours in the evening in his shop making his fishing rods, Uncle Sam Phillipi, and I have two or three of his rods. His first rods were rather rude as compared with rods as now made, but in his day were examples of fine rod making.

Then we have, as I said before, rods running in price from $25 to $75, although you find in the tackle stores rods as low in price as $1.50, but those you understand are made from the cullings of the cane. In the manufacture of split-bamboo rods there are only a few canes in a hundred fit to go into rods of first quality, and it all takes time to sort the canes, and it costs money.

We also have a collection of steel rods which have been brought to a very high state of perfection. There is also a fine collection of bethabara rods. There is also a fine display of reels. We have the finest reels made in this country, and America excels the world in the manufacture of fine goods in this line. We have Kentucky reels of modern make, and we have a collection of old Kentucky reels which are from fifty to seventy-five years old. There you can see the evolution from the first reel made by the old man Snyder down to the present reel.

We have, too, some very pretty girls who make a splendid exhibit themselves, where high flyers can see the fly-tyers. We have a manufactory there of fishing lines that is quite interesting and is well worth visiting. There is a very fine exhibit of baits and trolling spoons, and with this exhibit we have the first trolling spoon that was ever made. In addition to the multiplying reels, we have an automatic reel which is fancied by some fishermen. Of course, there is a large collection of other fishing tackle. In addition to this, we have a collection of literature on angling in the way of books that have been published in this country. There are also exhibited angling trophies, including the largest tarpon ever taken on a rod, the fish weighing 205 pounds, which was taken by a lady, Mrs. Stagg.

There is one thing I did not speak of, a very ingeniously contrived glass cylinder for inclosing a live minnow. The cylinder is surrounded by a *chevaux de frise* of hooks, and of course the glass does not show in the water. In other words, it is "carrying your bait in a bottle." There are several articles in the exhibit which are of interest aside from those of which I have spoken, but I cannot stop to enumerate them all. I would like to call attention, however, to a patent reel-seat, which was invented by our worthy President, as among the things I would like to have you see.

I hope the Society will take occasion to examine all these articles at their leisure.

FISHCULTURE IN MICHIGAN.

BY HOYT POST.

In this year of reminiscences, it may not be amiss to briefly review the work done in fishculture in Michigan. The record of this work is found in ten biennial reports of the State Fish Commission. This record, presumably like that of other States, shows some blunders, frequent mistakes, and many sad disappointments; but by persistence, energy and pluck, the blunders were overcome and the mistakes corrected, and the disappointments were borne with that Christian resignation which is a characteristic of the craft. As an illustration of this spirit of resignation, a quotation from the Second Report is in point. It says: "Now what is our lake and river farmer to do about it, when accident and insuperable force so confront him? What can he do more than did the honest Dutchman who, when he broke his leg, thanked the good Lord that it was not his neck. Few mortals, if any, can create circumstances, and the fishculturist's work, like all other human work, must take its chances."

The outcome has been a steady and continuous progress, resulting in a fair degree of success.

The Board of Fish Commissioners of the State was established by an act of the Legislature approved April 9, 1873. At this time seventeen other States had embarked upon the work.

The first Board of Michigan consisted of the Governor and the two appointed members, who were to hold office until the expiration of the next regular session of the Legislature. Their duty was stated to be "to select a suitable location for a State fish breeding establishment for the artificial propagation and cultivation of whitefish and such other kinds of the better class of food fishes as they may direct, upon the best terms possible." They were required to appoint a Superintendent of Fisheries of the State, and

to supervise generally the fishing interests and secure the enforcement of all the laws relating to the protection of fish and fisheries in the State. The fact that the whitefish was the only one specifically named in the organic act indicates the regard the people of the State had for this fish, and it has been often since cited as an argument against any neglect of that branch of the work.

The Governor at the time this legislation was enacted was Hon. John J. Bagley, of Detroit, whose interest and appreciation of the work had much to do with the passage of the law, as well as with the public interest in the subject and the early success of the Commission. His associates on the first Board were Andrew J. Kellogg and George Clark, the latter of whom had an experience of almost half a century in catching whitefish in the waters of the State.

The first Board was singularly fortunate in securing as Superintendent the enthusiastic and untiring George H. Jerome, whose spicy and vigorous contributions to the literature of the subject contained in the early reports of the Commission have won the admiration of each succeeding Board and of every appreciative reader.

The salary of the Superintendent was limited by the act to twelve hundred dollars, but the meagreness of the compensation did not hinder this enthusiast from giving to the work all the energy and ability he possessed. He was the life and spirit of the Board so long as he retained his place.

The following words from the First Report of the Commission are deemed worthy of quotation: "The water world, subject year by year to new discovery and to a larger development, may be implicitly relied upon in the years to come to contribute a much larger quota of food than at any pre-existing period. This, as viewed from the fishculturist's standpoint, is believed to be not merely possible, but highly probable. Indeed, this is the fish prob-

lem, nothing more, nothing less; and to the solution of this problem the veteran band of fishculturists, with the appliances at hand, and with a will and courage equal to every conceivable emergency, have gone to work, resolved not to lay down their tools till every promise of theirs is redeemed and every prophecy fulfilled."

The appropriation for the first two years was seventy-five hundred dollars a year. With this fund the Commission established a State hatchery at Crystal Springs, Pokagon, Cass County, on the Methodist camp-meeting grounds, and built a hatchery 20 by 60 feet, one story high, with a roomy attic, and a small residence for the overseer. The earlier efforts of the Commission were devoted somewhat to the propagation and planting of several kinds of foreign fish—the Atlantic salmon, the land-locked salmon, the California salmon and the shad; and we are constrained to believe that much faith and enthusiasm, as well as labor and money, was wasted in the effort to acclimate these foreigners to the waters of Michigan. The whitefish, however, was never overlooked or neglected.

The first plant of whitefish was in the spring of 1874, and it exceeded a million and a half, which was greater than the plant of all other kinds. These whitefish were hatched at the hatchery of N. W. Clark, at Clarkston, Oakland County.

In the spring of 1875, there were hatched at the State hatchery at Pokagon about 150,000 whitefish, and about two millions were bought of N. W. Clark & Son, of Northville, at the price of one dollar a thousand. The plant was upwards of twenty-two hundred thousand.

In the fall of 1876 a small whitefish hatchery, 20 by 50 feet, was built on a leased lot near the water works on Atwater Street, in Detroit, and the experiment tried of using the city water. Oren M. Chase was put in charge of this hatchery. The hatching was done at first in the Holton

hatching-box, for the use of which a royalty of $100 a year was paid.

In the spring of 1876 nearly ten million whitefish were hatched, and the plant in Michigan was nine million three hundred and ten thousand.

The rather boastful mention of this then unparalleled hatch in the Second Report of the Commission is somewhat amusing in the light of what is now being done in that line.

In the organic act provision was made for co-operation with other States contiguous to the waters of Michigan, which should make appropriations for the work and express a desire for joint action; and in the report of 1876 mention is made that several of the States bordering upon the Great Lakes, notably Ohio, Wisconsin and Minnesota, "have got sharply to work upon the whitefish."

The planting of salmon trout was begun in 1875, when one hundred and fifty thousand fry were purchased of N. W. Clark & Son, at the price of two dollars a thousand, and planted in the inland lakes of the State. The work on the Atlantic, the California and the land-locked salmon continued through the seasons of 1875 and 1876. In the meantime, Eli R. Miller, of Richland, had succeeded Governor Bagley as Commissioner, and was made President of the Board, the statute having been so amended as to provide for three Commissioners, one for two years, one for four years and one for six years, and their successors to be appointed to a term of six years each. The appropriations for 1875 and 1876 were seven thousand dollars for each year. Twenty-two States were at this time more or less actively engaged in fishculture.

In 1877, the whitefish plant exceeded eight millions. Some experiments were made in hatching the herring and the German whitefish. In the Third Report the Commission congratulates itself that while it had paid a dollar a thousand for hatching whitefish, it now was producing

them at a cost of not to exceed ten cents a thousand. The Chase automatic jar, an invention patented by Oren M. Chase, had now taken the place of the hatching-box, and was the means of greatly cheapening the production.

The hatching of lake trout and of California salmon and land-locked salmon was continued through the years 1877 and 1878, and experiments were made with the grayling, though with indifferent success. In 1877 the planting of eels was first inaugurated. They were taken in the Hudson, near Troy, and transported in cans.

In the Third Report the Superintendent concludes the California salmon is too large a fish for the great bulk of the inland lakes, and should be planted mainly in the rivers emptying into the Great Lakes. The brook trout work commences about this time at the hatchery at Pokagon, the take being from two to three hundred thousand eggs.

On October 14, 1877, George Clark died, and was succeeded by Dr. Joel C. Parker, of Grand Rapids, who continued as Commissioner by successive appointments until January 1, 1893. He held the office of Commissioner continuously longer than any other member, and gave much valuable work and thought to the subject of fishculture.

The appropriations for the years 1877 and 1878 were seven thousand dollars a year. Twenty-eight States were now engaged in fishculture. The plant of whitefish for 1878 reached the figures of upwards of twelve and a half millions, and for 1879 upwards of fourteen and a half millions. During these two years the work on California and land-locked salmon and trout and eels continued, and two new varieties, the German carp and the California or rainbow trout were introduced.

The appropriations for the years 1879 and 1880 were cut down to five thousand a year. On July 1, 1879, George H. Jerome resigned as Superintendent, and was succeeded September 15, 1879, by James G. Portman, of Watervliet,

Berrien county, and the only one of the old employees retained was Oren M. Chase, who had been overseer of the Detroit hatchery from its start.

Up to this time a considerable plant of whitefish fry had been made each year in several of the inland lakes of the State. No extensive reports of the favorable results of such planting coming to the Commission, the planting was thereafter confined to the Great Lakes and the rivers and straits connecting them, and such interior lakes as contained native whitefish; and thus another undoubted mistake was corrected. The Commission becoming convinced that the brook trout was capable of a much wider range throughout the State than was formerly supposed, began to give additional attention to raising and distributing this popular fish. The Fourth Report bravely suggests that not less than a million brook trout fry should be hatched yearly for Michigan streams.

A few black bass were hatched and planted, and some experiments made in hybridization. Renewed efforts were also made to accomplish something for the grayling, but without success.

About this time the few remaining adult California salmon were turned loose; his exit was preceded by that of the Atlantic salmon, and his by that of the shad, and thus was another mistake corrected. The land-locked salmon struggled along a few years later, but his name has since been stricken from the list.

In the summer of 1880, the Detroit hatchery was remodeled, and the last of the Holton boxes discarded and their places supplied with the Chase jars, giving a total of three hundred jars and a hatching capacity of more than thirty million whitefish fry. Six of these jars were exhibited by Prof. Baird at the International Exposition at Berlin, and Mr. Chase secured the "golden medal of honor" for the invention. About this time the trout and salmon in the ponds at Pokagon began to sicken and die,

and an analysis of the water demonstrated that it was not suitable for the trout work; and thereupon ground and water was rented at Boyne Falls, where through the liberality of Hon. Thos. S. Cobb, of Kalamazoo, a temporary hatchery was located. After one season's use, however, the dam was carried away by a freshet and the hatchery abandoned. The carp were retained at Pokagon for a while, but were soon after removed to Glenwood, where the carp hatchery has since been carried on under the supervision of Mr. Worden Wells, in ponds belonging to him, and with unvarying success.

The whitefish plant for 1880 was ten million six hundred and ninety-five thousand, and for 1881 only three millions. The cause of the falling off was the difficulty in procuring the ova on account of storms, and the failure of the Detroit river fishery, where the fish had theretofore been obtained. About this time the methods of securing the ova were much improved under the suggestion and experiments of Oren M. Chase, who found it feasible to retain the fish in small crates through which the water flowed freely, and to handle the fish from day to day, and take the eggs when ripe, thus making a great saving of the eggs and resulting in but trifling injury to the adult fish.

In July, 1881, the trout station at Paris, Mecosta county, was located on Cheeney Creek, and about 40 acres of land and the meander of the creek 15 rods wide across 120 acres more were purchased.

Here in the early fall of that year was built a trout hatchery 20 by 60 feet, a dwelling house and barn; and the hatchery and ponds at Pokagon were abandoned.

The principal trout work of the State has been conducted at the Paris station ever since without any serious drawbacks. The work, however, has now about reached the limit of the water supply, and one neighboring stream

has already been brought over in pump logs, and it is contemplated doing the same with another.

The whitefish plant of 1882 was upwards of eighteen millions. That spring, the experiment was first made with the wall-eyed pike, and a plant was made of eleven hundred and twenty thousand.

The Board had some difficulty with Superintendent Portman, and in September, 1882, he was succeeded as Superintendent by Oren M. Chase. Mr. Chase served until November 11, 1883, when he was drowned in Little Traverse Bay, while in the performance of his duties, sacrifiing his life in his zeal for the work. Walter D. Marks was then made acting Superintendent until March 26, 1884, when he was regularly appointed Superintendent, and continued to act in that capacity until the early part of 1893, when he resigned. Mr. Marks was an early pupil of the veteran Seth Green, and was a man of large experience in handling the breeding fish. He was full of resources and always found some way out of every difficulty that beset his work.

January 1, 1883, Eli R. Miller retired as Commissioner at the expiration of his term, and John H. Bissell, of Detroit, was appointed his successor. The work had reached a somewhat low ebb at this period and needed just such an energetic, thoughtful and practical man as he proved to be, to give it a new impulse. It is no disparagement of any one else to say that Mr. Bissell is entitled to as large a degree of credit as any one for such success as the Michigan Fish Commission has attained.

The appropriation for 1881 was eight thousand dollars, and for 1882 seven thousand five hundred dollars. In the fall of 1883, the work of obtaining accurate statistical information as to the amount and value of the commercial fisheries of the State was commenced in a small way. The whitefish plant of 1883 was twenty-three million seven hundred and thirty-five thousand, and that of 1884, thirty-

seven million seven hundred and fifty thousand. The brook trout plant of 1883 was two hundred and sixty-nine thousand, and that of 1884 was three hundred and fifty-three thousand.

In the Sixth Report it is again urged that there ought to be hatching-house room sufficient for at least a million brook trout. In 1883 a new site was chosen at the corner of Joseph Campau avenue and Lafayette (now Champlain) street, for the Detroit whitefish station. This site is 100 feet square. The lots were rented, and a hatchery 40 by 80 feet built with a shop and barn 30 by 46 feet in the rear along the alley. This building cost about fifty-six hundred dollars, and was equipped entirely with Chase jars. It held 812 jars, with a hatching capacity of about forty-two million whitefish eggs. About this time more land was purchased near the trout station at Paris, and the ponds increased and grounds much improved.

In August, 1883, a whitefish hatching station was established at Petoskey, upon leased grounds, but for various reasons, principally connected with the condition and quality of the water supply, this proved another mistake, and a somewhat costly one, too. Without going into detail, suffice it to say that this hatchery, after being used two or three years, had to be abandoned. As early as 1883, a movement was inaugurated towards the establishment of a whitefish and trout hatching station upon Lake Superior, but it did not result in anything tangible until several years later.

In October, 1883, a meeting was held at Detroit of the Fishery Commissioners of the States bordering the Great Lakes, upon invitation of the Michigan Commission. Commissioners attended from Minnesota, Wisconsin, Ohio and Michigan, and a representative of the United States Fish Commissioner was present. A movement to secure uniformity of legislation led to the consideration of the subject of Federal supervision of the fisheries of the Great

Lakes. At the request of the Michigan Fish Commission, Mr. Otto Kirchner, then Attorney-General of the State, examined the authorities and presented an able brief to the point that the Federal Government had no jurisdiction of the subject, and that such protection as we had must come from the authorities of the several States. This conference was productive of much good feeling, and undoubtedly helped on the work of uniform legislation of the several States bordering the Great Lakes for the protection of the fishing interests.

In February, 1883, a Secretary of the Board was appointed for the first time. Herschel Whitaker was appointed and served until June 1, 1884, when he resigned and Andrew J. Kellogg succeeded him. Mr. Kellogg served until March 20, 1888, when he was succeeded by George D. Mussey, who has served ever since. On the resignation of Mr. Kellogg as Commissioner, to take the appointment as Secretary, Mr. Whitaker was appointed Commissioner in his place, and has continued in office to the present time. The combination of Mr. Whitaker, Mr. Bissell and Dr. Parker made a strong Board, and from this time on a new impetus was given to the work. The business was organized and the work classified and systematized as it never had been before. Through their influence larger appropriations were obtained and the work extended in every department.

The Commission in 1884 obtained control of one of the fisheries on the Detroit river, and this policy has been extended until now they control all the fisheries on the American side of the river.

The Sixth Report sums up the condition of fishculture in 1884 as follows: "The present aspect of this subject is far different in many respects from what its advocates and promoters of ten or more years ago believed it would be at this time. The general enthusiasm of the early movement as it seized upon the naturalist and sportsman

of ten or fifteen years ago in the blush of its first successful experiments has not entirely faded away, but has ripened into a deep conviction on the part of an ever-increasing number of intelligent men, that fishculture has solved one half of the question, Can the fisheries be preserved? and has now settled down upon business-like principles and methods to do its part. The other half of that question must depend for its answer upon wise measures for protection. This is true of almost every State and Territory in the Union." The appropriations for 1883 and 1884 were ten thousand dollars for building and equipping new stations, and ten thousand dollars a years for current expenses.

In August, 1885, Mr. Lyman A. Brant was appointed statistical agent for the Board and visited all the commercial fisheries of the State, and made a full report in writing of his work, which was much the best of its kind that had thus far been done, and afforded the Commission much needed information.

The whitefish plant for 1885 was forty millions, and for 1886 was sixty-one million six hundred and twenty thousand; a few Loch Leven trout were planted and the plants of California trout were continued, but the adult fish did not do well in the stock ponds, and many of them were liberated. Further experiments with the grayling were continued; a large portion of a grayling stream was stocked with them and barriers erected to prevent their escape, and every inducement provided for them to spawn in a semi-wild or natural state, but the experiment was a failure. Additional ponds were built at the Paris station and the grounds otherwise improved by grading and sodding. Further agitation was given to the question of the Upper Peninsula whitefish station. A scheme of systematic examination of all the inland waters of the State seriatim was inaugurated. For this purpose a double crew of men was sent into the field, and charts of each lake examined

were made and filed in the office, to be bound in books. These charts contain a rough sketch of the shape of the lake, give their name and location, dates of examination, kind of bottom and shores, temperature at top and bottom and surroundings, number and kinds of fish caught and how, their condition and what feeding upon, the kinds and condition of fish food in the water, and recommendation as to kinds of fish to plant. This work has been continued each year until at present there are complete records of upwards of four hundred lakes which have been examined, the reports of which are bound together in volumes indexed and easy of reference. These volumes are consulted in passing upon applications for fish plants in the waters.

The capacity of the trout hatching house at Paris has already reached a million and a half, and a new house is recommended to increase the capacity to three and a half millions.

The hatching and planting of whitefish, brook trout, lake trout, wall-eyed pike, carp, Loch Leven trout, landlocked salmon and California trout was continued through the years 1887 and 1888. In 1887 the first plant of German trout was made, and the rearing of this fish has been continued ever since and much increased in later years. It seems to thrive in Michigan waters and has every appearance of being a hardy and a vigorous importation.

In 1887 a new additional trout hatching house 40 by 82½ feet was built at Paris, at a cost of about $4,000 for the house and fittings. The old hatching house was dismantled, but remains standing and is used for a store house and shop. It is capable of being restored and put in commission again on short notice and at small cost, if needed. The capacity of the Detroit whitefish house was increased by the addition of the jars removed from Petoskey, so that it now contains 525 jars, which would hatch eighty to ninety millions of whitefish a year.

In 1888 the Commission had a car built for transporting fry and fish. It is over 55 feet long and substantially built, with passenger coach trucks, air brakes, platforms, coupler and buffers, so that it can be easily hauled in any passenger train. It has an office at one end and a kitchen at the other, and is fitted with five berths, enabling the men to live and sleep on the car. Its capacity is 175 cans. It is named "Attikumaig," the Chippewa name for the whitefish, meaning literally the "deer of the water." This car has proved a great convenience, and has been the means of cheapening the distribution of fish and fry. It has been in continual use from February till the latter part of June of every year since it was built. The plant of whitefish in 1887 was seventy-two million nine hundred and eighty-four thousand, and in 1888 about the same number. The brook trout plant in 1887 reached one million, and in 1888 was over a million and a half. The wall-eyed pike plant of 1887 was three million two hundred and eighty thousand, and in 1888 eleven million four hundred and ninety-two thousand.

Mr. Bissell's term of office expired January 1, 1889, and Hoyt Post, of Detroit, was appointed his successor. On March 20, 1888, Mr. Kellogg resigned as Secretary, and the present Secretary, George D. Mussey, succeeded him.

In 1888 and 1889, the Secretary made trips of investigation of the fisheries and filed written reports, which are printed in the biennial reports of the Commissioners. In January, 1890, Mr. S. C. Palmer continued this work on a more extended scale. During the years 1891 and 1892, Mr. Charles H. Moore engaged in similar work for the Commission and obtained complete reports of every fishery in the State, his work being as complete as could be made. Experiments were made in hatching sturgeon eggs, and a few were successfully hatched. A successful hatch was also made of the eggs of white bass. These eggs are very small and hatch in about forty-eight hours.

Subsequently larger quantities were successfully hatched in the Chase jar.

The Commission has made several fish exhibits, embracing nearly all varieties of native fish, at the State Fair and the Detroit Exposition, and elsewhere. These exhibits were comparatively inexpensive and were very attractive, and proved valuable aids in disseminating knowledge of fish and fishculture. The Report of 1890 was the first illustrated Report issued. It contains cuts illustrating the hauling of the seine, and the stripping of fish, and interior and exterior views of the hatcheries, and of the ponds and grounds at Paris, which added much to the attractiveness of the Report.

Some attention now began to be given to scientific work, and Prof. Jacob Reighard, of the University of Michigan, began his investigation of the development of the wall-eyed pike. The motive that first led to this investigation was the discovery of the cause of the large percentage of loss in hatching the eggs of this fish, as compared with those of the whitefish. He made extended microscopical examinations and accompanied the men in the field and followed the eggs to the hatchery and watched their development and hatching. He reduced his observations to writing, furnishing an article of upwards of 60 pages, with microscopical drawings, which was published in the Ninth Report, with plates and drawings. This article is regarded as a most valuable contribution to the literature of fishculture and has been in great demand. Prof. Reighard also conducted like experiments with whitefish eggs. He also accompanied the crews for examination of waters with his microscopes and an assistant and a botanist, and made quite extensive examinations of the fish food and aquatic plants, and incidentally of some fish parasites. He also prepared a still more elaborate article on the development of the embryo of the wall-eyed pike, covering about eighty pages, which with the plates illustrating it are pub-

lished with the Tenth Report. He is at present inaugurating some experiments connected with the food of the whitefish, and its life and abundance, and when and how distributed, which it is hoped will be of value in determining the proper places for planting the whitefish fry. It is designed to make this examination as careful and exhaustive as the means at hand will allow, and it is planned to interest the authorities of the University of Michigan, to co-operate with the Commission in extending work of this scientific nature from time to time. No work of the Commission has attracted wider attention among intelligent readers than the work already done by Prof. Reighard.

A boiler and pump were added to the Detroit hatchery for use in case of an emergency causing the stoppage of the flow of the city water, such as had been once or twice experienced. By this means the water in the storage tanks could be on short notice pumped up into the troughs which feed the hatching jars and keep the water circulating through the eggs until the stoppage of the regular flow of the city water ceased. The storage tank capacity of the hatchinghouse was also nearly doubled by enlarging the wing of the building.

In the summer and fall of 1889, the efficiency of the Detroit whitefish hatchery was doubled by the erection of two additional frames of jars, which increased the number of jars in place to one thousand and fifty, with a hatching capacity of nearly two hundred millions; but the difficulty of obtaining sufficient ova to fill the jars prevented for a year or two reaping the full benefit of the increased capacity. The whitefish plant in 1889 was sixty-three millions, and in 1890 one hundred million seven hundred thousand. The wall-eyed pike plant of 1889 was forty-four million three hundred and forty thousand, and in 1890 twenty-two million three hundred thousand. The brook trout plant of 1889 was two million four hundred and sixty-

eight thousand, and in 1890 two million five hundred and seventy-eight thousand. The appropriations by this time had increased to upwards of twenty thousand dollars a year, and the inventory of the property of the Commission showed a valuation of upwards of thirty-five thousand dollars.

The Tenth Report covers the years 1891 and 1892, and is a substantial volume of 228 pages. In the fall of 1891 a small hatchery for whitefish, lake trout and brook trout was established at Sault Ste. Marie, containing 200 jars, besides such hatching troughs as the space in the building would admit. The city paid the rent of a small store building in which this hatchery was set up, and furnished city water free. This hatchery was run during the seasons of 1891 and 1892, but owing to difficulty and disappointment in procuring whitefish ova, was not filled until 1892. The purpose of a whitefish hatchery on Lake Superior, was to provide for stocking that great lake; the hatch at the Detroit house coming too early to be planted on account of the ice in the harbors.

It was thought that the difference in the temperature of Lake Superior water would retard the hatch about two or three weeks, which proved to be the fact. The water at the Sault proved admirably adapted to the work, both of hatching whitefish and brook trout. The temperature of the water is remarkably even and cold. It began November 15, at 42°, and for the month ensuing varied from 42° to 38°, and about January 1, ran down to 34°, where it remained without variation to exceed one degree either way until April 20, and from then until May 15 it did not go above 40°. A daily record of the temperature of the water is kept at each station while in operation.

The appropriations for 1891 and 1892 exceeded $27,000 a year, and those just granted for the years 1893 and 1894 are $25,000 a year. The inventory of the property has increased to nearly $38,000.

Never till the fall of 1892 had the Detroit hatchery been completely filled with eggs. In that year the Commission controlled all the fisheries on the Michigan side of the Detroit river, and instead of letting them out to others to fish, hired the fishermen and absolutely controlled and directed the fishing.

Through the energy, persistence and skill of the Superintendent, W. D. Marks, in conducting this work, more fish were caught and more eggs taken than had ever been before. The total number of whitefish caught was 13,074, the total eggs taken was 4,544 quarts or 142 bushels, making 173,630,400 eggs. It was a beautiful and inspiring sight to look upon the tiers of jars in the Detroit house, more than a thousand in number, all filled and in active operation. It is a sight never equalled elsewhere and but once there.

The whitefish hatchery at Detroit is undoubtedly the largest, best arranged, best equipped, most economical and most efficient in the world. No other has begun to compete with it in out-put. And there are few, if any, brook trout hatcheries that excel the one at Paris.

The whitefish eggs are placed in the jars in November and December, and remain from 130 to 140 days, or until March and April, before they hatch; and the fry are no more than out of the way before the same jars are filled with the eggs of the wall-eyed pike, which are placed in the jars in April and May, and hatch in 28 or 30 days, coming out the last of May and first of June.

It has been the habit of the Board for the past few years to hold regular monthly meetings and such special meetings as may be found necessary, and full records are kept in writing, in bound volumes, of the proceedings, including everything of interest in fishculture which comes to the attention or knowledge of the members from time to time.

Full books of account are kept of all the money transactions. All payments are by checks signed by the mem-

ber of the auditing committee who certifies to the account, and vouchers in duplicate are taken for all payments. William A. Butler, Jr., of Detroit, has been Treasurer of the Commission since about 1883.

Bound volumes are kept of the statistical reports and examining crews. All applications for fish are in writing on printed blanks furnished, which describe the location and character and temperature and soundings of the water, and the surroundings where it is proposed to plant the fry.

In January, 1893, the term of Dr. Parker expired and Horace W. Davis, of Grand Rapids, was appointed his successor.

In December, 1892, an International Fish Conference was held at Detroit, under the auspices of the Michigan Commission. There were present Samuel Wilmot, of Ottawa, Canada; Edward Harris, of Toronto; Thomas Marks, of Port Arthur; and W. S. Wells, of Chatham, Ontario, and members of the Fish Commissions of New York, Ohio, Minnesota, Maine, and many others from different States, including some fishermen. The subjects discussed were connected with uniformity of legislation protecting fish and game, and more particularly the vital question of a close season for the commercial fish. The main results of the meeting were embodied in a report of a committee which was adopted as follows, viz:

"1. That all small fish and others unfit for food of all kinds, when taken in nets, should be replaced in the waters when taken alive; that fishermen should not be allowed to take such fish on shore nor expose them for sale.

"2. That no strings of pound nets used in the lakes shall extend more than four miles from shore.

"3. That one-half part of all channels between islands or elsewhere—where fish migrate to spawn, shall be kept free from nets of all kinds at all seasons.

"4. That all whitefish taken of less than sixteen inches in length, and all salmon trout less than two pounds in weight, shall be immediately returned to the waters where taken and shall not be exposed for sale.

"5. That the month of November in each year be made a close season for whitefish, herring and salmon or lake trout.

"6. That all penalties fixed for violation of any laws that shall be enacted shall be made not only to apply to those who take fish, but also to all persons who buy, sell, transport or have the same in possession."

The following resolution was also passed, viz.:

"*Resolved*, That the law should authorize the seizure and destruction of nets used in violation of law."

Throughout all the ten reports of the Commission are frequent acknowledgments of courtesies and exchanges with the Commissions of other States, and especially with the United States Commissioner, to whom the Michigan Commission is under many and acknowleged obligations for continued favors and grants of eggs and fry, and fish of varieties that could not be elsewhere procured.

The Michigan Commission would be guilty of gross ingratitude and lack of appreciation if it ever permitted any account of its work to go forth without due acknowledgment of its obligations to the railroads of the State, without whose aid, given for the asking and without stint, it could never have accomplished anywhere near what it has.

Ever since the organization of the Commission it has at each legislative session given much time and attention to procuring the passage of proper protective legislation to preserve the fisheries; but it seems much easier to get legislation through to propagate fish than to lay any restrictions upon the catching. As against any such restrictions an active and not over-scrupulous lobby always appears on the scene, and cries out about the ruin and destruction of

their property and investments, and who ever knew a legislature that was proof against such a plea.

Appended to this article is a complete table of the totals of all plants of fish of all kinds that have been made by the Michigan Commission, taken from their Tenth Report:

TOTAL PLANTS OF BROOK TROUT IN FOURTEEN YEARS.

1879	12,000	1886	719,000
1880	50,400	1887	1,090,000
1881	388,500	1888	1,639,000
1882	251,000	1889	2,468,000
1883	219,000	1890	2,578,000
1884	353,000	1891	2,500,000
1885	408,000	1892	2,422,000
Total			15,097,900

The above is a statement of the plants of brook trout made from the Paris station from and including 1879, the year in which the trout work of the Commission was removed from Pokagon to Paris.

TOTAL PLANTS OF WHITEFISH.

1874	1,532,000	1885	40,000,000
1875	2,211,500	1886	61,620,000
1876	9,310,000	1887	72,984,000
1877	8,001,000	1888	72,968,000
1878	12,520,000	1889	63,000,000
1879	14,545,000	1890	109,700,000
1880	10,695,000	1891	104,000,000
1881	3,000,000	1892 (from Detroit station)	65,500,000
1882	18,170,000	1892 (from Sault Ste. Marie station)	9,724,000
1883	23,735,000		
1884	37,750,000		
Total			740,965,500

TOTAL PLANTS OF WALL-EYED PIKE.

1882	1,120,000	1889	44,340,000
1884	2,040,000	1890	22,300,000
1886	1,806,256	1891	27,045,000
1887	3,280,000	1892	57,300,000
1888	11,492,000		
Total			170,723,256

TOTAL PLANTS OF CARP.

1881	1,093	1889	3,490
1885	2,088	1890	5,798
1886	3,422	1891	2,231
1887	2,843	1892	2,025
1888	3,878		
Total			26,868

TOTAL PLANTS OF ATLANTIC SALMON.

1873	21,350	1874	139,000
Total			160,350

TOTAL PLANTS OF CALIFORNIA TROUT (FRY).

1880	12,000	1889	4,000
1884	6,000	1890	16,000
1885	25,000	1890 (adults)	475
1887	20,000		
Total			83,475

TOTAL PLANTS OF SWISS LAKE TROUT.

1890	17,360

TOTAL PLANTS OF LOCH LEVEN TROUT.

1885	8,000	1890	30,000
1888	5,000		
Total			43,000

TOTAL PLANTS OF BROWN TROUT.

1889	20,000	1891	156,000
1890	60,000	1892	271,500
Total			507,500

TOTAL PLANTS OF LAKE TROUT.

1875	150,000	1886	490,000
1877	168,500	1889 (two years old)	13,000
1878	433,834	1890 " " "	467
1879	379,000	1892 (from Sault Ste. Marie station)	204,000
1880	26,500		
1885	215,000		
Total			2,080,301

TOTAL PLANTS OF SCHOODIC SALMON.

1876	20,300	1885	48,000
1878	26,000	1886	23,000
1879	4,867	1887	23,636
1880	20,000	1888	73,424
1882	13,517	1889	5,000
1883	27,874	1890	44,000
Total			329,618

TOTAL PLANTS OF CALIFORNIA SALMON.

1873	45,900	1878	73,000
1874	419,930	1879	215,246
1875	323,000	1880 (adults)	575
1876	227,000		
Total			1,304,651

TOTAL PLANTS OF EELS.

1877	265,000	1883	236,000
1878	405,000	1885	325,000
1879	317,000	1891	273,000
1881	390,000		
Total			2,211,000

TOTAL PLANTS OF BLACK BASS.

1880	3,500	1888	1,560
1881	7,000	1890	185
Total			12,245

TOTAL PLANTS OF WHITE BASS.

1891	2,500,000

The aforesaid biennial reports contain detail statements of the place of each plant, date of delivery and to whom, and amount of each.

From the annexed table it will appear that the total plants of whitefish aggregate the large number of nearly seven hundred and fifty million, commencing in 1874 with little above a million and a half. The twenty million point was not reached until 1883, the fifty million point until 1886, nor the hundred million point until 1890, so that more than half the whole number have been planted within the past five years.

It is matter of deep regret to every one connected with or interested in the artificial propagation of whitefish that actual and tangible demonstration of the results of such large plants, cannot in the nature of things be obtained. The results of brook trout planting in streams are so open to inspection and so easily observed and appreciated that

it is not difficult to convince any caviller by proofs and demonstration that cannot be gainsaid; but to reason from analogy it would seem that if the relatively smaller output of brook trout has produced such remarkable results as they are known and acknowledged to have, the millions of whitefish and wall-eyed pike that have been planted in the Great Lakes must have made a marked impression on the commercial fisheries, and yet frankness compels the admission that thus far the increased catch of adult whitefish is not at all commensurate with what it seems ought to have been expected as the outcome of these great plants. It is true there are many things to be taken into account in this matter, not the least of which is the slaughter of immature fish; but it would be very gratifying if the actual outcome of these plants could be proved as it can with the plants in the streams.

A SUGGESTION:

THE SPECIALIST IN FISHCULTURE.

BY W. DAVID TOMLIN.

In all lines of business, the specialist has become a factor. In engineering circles the specialist is called in to examine the plant before it is started, even though a consulting engineer has supervised the construction all through.

In electric engineering, after the contract is completed, a specialist carefully examines the entire system; not alone to test the efficiency, but to look for the most economic methods of operating the system.

Specialists are not confined entirely to the medical profession. The demands of American business life call for the most improved systems that can be devised to furnish

our people with food and comfort; with the best of raiment, with homes adorned with all that is beautiful, and replete with such surroundings that will conduce to the lengthening of our days, and to take off the sharp edge of erroding care that so stealthily eats into the life of even the strong man.

Among the tasty tid-bits that so many enjoy is the planked whitefish—the *Coregoni* of Lake Superior—becoming year by year a scarcity.

The States west of Lake Superior—Minnesota, the Dakotas, Montana, Colorado and Iowa—demand whitefish early in the season, and continue the demand as long as there are possibilities of getting them. In all these Western States they are staple articles of fish food when they can be procured; but the decrease is rapid, and unless some means are devised to restock the waters that formerly produced them, the fishermen will not find a school of such fish in a single season's catch.

At present we are dependent upon Canadian fishermen to largely supply our Western markets. We are brought to face the subject, American fishermen cannot get whitefish within one hundred miles of their home ports, and year by year the nets and boats have to go further up into Lake Superior to find any whitefish for the home market, let alone the demand for the same fish for the market in the States west of us.

Mr. Milner sounded the notes of warning: "That the whitefish were decreasing in 1872." At that time the fishermen could get nets fairly well filled with them in Lake Superior waters within 12 to 20 miles of Duluth; today the fishermen must go 160 miles up into the same lake to get any of these fish, and if the ice is late in breaking up and going out, the fish have visited the grounds and departed before the fishermen get to the fishing grounds. These fish visit Isle Royale late in the fall to spawn, and

the only large catch of whitefish must be made at that time, or the fishermen get none during the season.

The question arises and is often discussed with some vigor, is there no remedy for this state of affairs? Cannot Lake Superior be restocked with whitefish?

There are two points worthy of consideration. One is a national law demanding that the fishermen shall be compelled to strip and deposit the spawn of the whitefish, just as the State laws of the State of Wisconsin demands and enforces.

Another point is, the employment of specialists that shall go out with the fishermen during the spawning season and teach them to carefully handle the fish and impregnate the eggs, and then interest the fishermen in the work so as to deposit the eggs in the best places to secure food for them when hatched.

Fishermen are often charged with carelessness, destroying young fish, by using meshes too small to let the smaller fry escape. I have not so found them, from some years' experience with them. I have learned that measures looking to the introduction of larger mesh nets have been considered, and a bill was introduced into the State Legislature demanding the increase of the size of meshes full $\frac{3}{4}$ of an inch string measure; in matters pertaining to the development of fishing interest these men are alive, and look to their own interests.

This measure of securing an expert or a "specialist" to spend one or two seasons with the fishermen on the Great Lakes during the time the fish are spawning, and to get them interested in the best manner of propagating fish fry, came from men who have been obliged to go out of the fish business, because there is no money in the business; their capital stock lay too long idle and no means of remuneration offered them—"They must make hay while the sun shines"—and the whitefish fishing became so poor they perforce sought other occupations.

Perhaps I am asked, Have any of the fishermen ever attempted to spawn fish, and if so, what were the results?

Yes, more than half a dozen of them; for results I will give a report to a gentleman connected with the Fish Commission:

"One of our men who lives up the lake quite a long ways, always spawns all the fish he finds that are in a fitting condition to be stripped, and has done so for five years; the result is he sends fish uniform in size, and more in quantity, and perhaps has not to go so far to catch fish as any other men who send fish to us. The lake within a few miles of his home is a splendid fishing ground. While other grounds have been fished out, this man is prosperous, intelligent, and is making money right along. Now, if he can do this with lake trout, why cannot other fishermen be taught to strip and spawn whitefish?"

This is not an isolated case; at Fishermen's Home on Isle Royale there is another fisherman who has been stripping fish as they came in ripe, and depositing the impregnated spawn. The captain of one of the fishing tugs has attempted the stripping of ripe fish and carried a tin bucket for this purpose; these three of the half dozen have perhaps been the only ones who have kept up the practice, but the mass of the fishermen have at different times urged the necessity of planting the spawn on the grounds where nature has provided food for the young fry when hatched.

Does some one ask, Is there a necessity for incurring this expense? Does not the increasing demand for this foremost of all fishes for table use justify the demand for some extra expense? Does not the decreasing numbers of these fish call for some extra efforts to replenish the waters formerly prolific with them?

Does not the fact that tugs come into port the first week in June, and report the fishing "played out" demand that

something be done to provide for the restocking of the whitefish grounds?"

Is it not sufficient to convince any thinking mind, that six years ago, four steam vessels hailed from this port [Duluth], and scoured the fishing grounds of Lake Superior for lake trout and whitefish; while at the present date there is but one steam tug engaged in the fishing business, and before the middle of June, this is coming in with but half catches, and announces that the fishing is about gone up for this season.

It is useless to send out men to gather spawn, who cannot resist the impulse to *sit down vigorously* when a boat is rolling. It is more than useless to send out men to gather spawn, who will made a fire on the beach, *and sit and warm themselves*, while the fishermen are either coaxed or bluffed into getting spawn for them. If fishermen can be taught to gather spawn, then by all means let the experiment be tried. It is better to let fishermen attempt to gather spawn, and realize 40 per cent. for the quantity gathered, than to have men sent out for this specific purpose, go to sleep in the pilot house of the tugs; while the fishermen dump such eggs that are taken into a bucket, nilly willy, leaving the eggs to the chances of impregnation.

Fishermen have made successful spawn takers, have raised 80 per cent. of the spawn so taken, and brought out strong, healthy fry; what one fisherman has done, others can be taught to do.

Then by a careful selection of sober, industrious men, apt to learn, quick-witted, of habits of thought capable of improving their surroundings, with fingers that follow the impulses of their minds, and who by their earlier experiences can stay in a rolling boat and secure eggs, without paying tribute to the genii of the unsalted seas by casting up their last meal.

The situation demands some thought of fishculturists.

Should we stand with folded hands, and see this denizen of these great lakes pass into the records of the U. S. Fish Commission, while the coming generation shall say, That was an age that consumed, but did not produce.

SALE OF DOMESTICATED FISH.

BY W. F. PAGE.

If the subject on which I now address you needs apology it may be found in the first Article of the Constitution of this Society. Therein it is stated among other things that the object of this Society is "to promote the cause of fish-culture, and the uniting and encouraging of the interests of fishculture."

During the past three years, my attention has been several times called, more forcibly than ever before, to the harassing restrictions placed by several of the States upon fishculture when conducted as a private enterprise. I have reference to the clause existing in the laws of several States prohibiting the sale of artificially reared fish within the close season prescribed for the protection of wild fish.

In the framing of many of the protection laws of the States it would seem that folly had joined hands with wisdom. For these protective laws were in themselves the direct outgrowth of the repeated earnest recommendation and solicitation of fishculturists. It cannot be believed that it was any part of the intention of the solicitors that laws should be enacted or so constructed as to harass, hamper and strangle fishculture. It is unreasonable that any State fostering fishculture at State expense in maintaining hatcheries under the plea of furnishing its citizens

with cheap and healthful food, should in substance say to a tax-paying citizen, "You must not sell your artificially reared fish to our people until such time as Dame Nature can furnish us the same article." By its creation and maintenance of a Fish Commission, empowered to restock the streams, the State recognizes the desirability that its people should have an abundant, cheap food; and by its imposition of a tax on private fishcultural establishments it says, in effect, that the business is legitimate; but all this is unsaid when it denies to the taxed industry the right to sell its products in accordance with the demands of the market. It is worse than taxation without representation, it is taxation with strangulation. The error consisted at the time of framing the laws in not recognizing the vast possibilities of fishculture for supplying the market demand, in not distinguishing between wild trout and those artificially raised. Some of the States promptly modified their laws. But it is amazing that others persist in refusing to distinguish between State property and private property. If the expansion of fishculture so earnestly wished and worked for is ever to be realized in America, this stumbling block of over-protection must first be removed. As a step toward the consummation of this end I offer for your consideration the following:

At a meeting of the American Fisheries Society, held in Chicago, May 15, 1893, the following preamble and resolutions were presented:

Whereas, The cultivation and raising of trout as a food product being now an established industry in many of the States, furnishing employment to individuals, profitable investment for capital, and food for the people, and whereas the business is capable of great expansion, thereby furnishing the people with a food product of the highest class, and whereas the object of this Society is to encourage the cultivation of useful fishes as a food product, and

whereas this Society views with regret the laws of several States which interfere with the above industry ;

Resolved, That this Society favors legislation which will permit the sale and possession for food of trout and other useful fishes, which are artificially raised in private ponds and streams, at any time when within the provisions of the health ordinances.

WHAT WE KNOW OF THE LOBSTER.

BY FRED MATHER.

Within a few years much has been learned of the life-history of our common lobster that we did not know before. We knew that the female carried the eggs after extrusion, attached in masses to the so-called swimerets under the abdomen, which is improperly called the "tail," and that they hatched there. In Bell's "British Crustacea" it is said that the mother cares for the young after hatching and can recall them for protection. My own observations are that the young scatter and find protection in the rocks.

I am satisfied that the lobster carries her eggs all winter, and that all those laid after the middle of July, in Long Island Sound, will not hatch the same year, but eggs taken late last year afford a chance to give some figures which may be of value. On August 11, 1892, we took from 12 lobsters 43 fluid ounces of eggs, which by actual count measured 6,000 to the ounce, and on August 16 took from 33 lobsters 94 ounces, making in all 822,000 egg or 18,266 per lobster. We could not keep these eggs all winter, and they showed only slight developement a month later.

No work that has occupied the attention of fishculturists compares with what may be done in replacing the lobster

industry on the footing which it held in comparison to the population of the country 40 years ago. Then, a lobster of five pounds was a small one, now, one half of that weight is large, and the numbers have decreased in even greater proportion. The only things that approach the utility of lobster culture in economic importance is the hatching of whitefish on the Great Lakes, and the shad in the rivers; the trout and salmon will not compare with the lobster in value, if the latter can be increased as the former have been.

It is possible to bring this neglected branch of fishculture to a point where it will, on the seaboard, at least, overshadow the other branches in which we have been engaged.

After making notes about lobsters carrying their eggs all winter, when laid after July 15, I received the following letter from Prof. Samuel Garman, of the Museum of Comparative Zoölogy, Cambridge, Mass., dated August 30, 1892:

MR. FRED MATHER:

Dear Sir: I am very glad to get your reports and to know that you are pushing inquiries into the life-history of the lobster and the fishes which you propagate. I take pleasure in sending you a little report of my own on the lobster.

Very truly, S. GARMAN.

To say just how I rejoiced to find that Professor Garman's studies confirmed my own crude observations is beyond my power. It is pleasant to have one's ideas confirmed by any one who has studied the subject more than he has; but I will quote Prof. Garman's paper entire:

REPORT ON THE LOBSTER.

BY S. GARMAN,

MUSEUM OF COMPARATIVE ZOOLOGY,

CAMBRIGDE, MASS., Dec. 17, 1891.

Hon. E. A. Brackett, Massachusetts State Fishery Commissioner:

SIR:—Yours, with inquiries regarding the conclusions reached in the study

of the lobster, is at hand. While unavoidable delay in the drawings prevents placing the complete matter in your hands, it is quite possible to give you in a few words a general idea of the results and their bearings, such as will no doubt sufficiently answer your questions.

According to the arrangements made, some of the eggs from berried lobsters kept for the purpose were sent me at regular intervals through an entire year. These eggs were at once examined to note their progress in development, and they were then preserved by various methods for future studies and comparisons. After their young were hatched the females themselves were dissected, to observe the condition of the ovaries, and to determine the time when another lot of eggs might have been expected from them. As our work began in midwinter, it was necessary to follow certain specimens up to the hatching, and then to take others to complete the series from the laying. Eggs supplied me as freshly laid were so far advanced as to indicate that fertilization had taken place before they were placed under the tail of the lobster bearing them. The time and process of fertilization has not been discovered; but in all likelihood the marine lobster does not differ greatly in these respects from its freshwater relatives, the crayfishes. In the case of the latter the male seeks the female some time before the eggs are laid, and deposits the fertilizing matter on the upper side of the body, near the external openings of the oviducts, where it adheres for a time as a whitish mass. How the fertilizing elements, the spermatozoa, come into contact with the eggs and enter them, has not yet been observed. The development of the embryo in eggs laid on the seventh or eighth of August was so rapid that on the third of September the eyes were visible as thin crescent-shaped spots. As the waters grew colder the progress was retarded, until the changes were very slight indeed. This condition was maintained throughout the winter, and it was only when the summer temperature was reached that rapidity of advancement was again to be noted. The young began to hatch on the fourteenth of July; all of the eggs on a female seeming to be about equally advanced, the entire brood emerged at very nearly the same time. Examination of the ovaries, after their young had left, showed that the females would not have laid eggs again for a year; that is, not before the summer next following that in which they had hatched a brood. In other words, the dissections proved that the lobster lays only once in two years, hatching a brood one summer and laying eggs the next following summer for another brood. The time required in the development of the embryo is so long as to preclude hatching the eggs under ordinary circumstances during the summer in which they are laid. Artificial conditions might readily be brought about, by heating the water in which the specimens are kept, which would hasten the progress and greatly shorten the period between laying and hatching; but normally the winter temperature induces an almost complete suspension of advancement.

By the small number of specimens kept, it was not possible to fix the lengths of either the laying or the hatching periods. This, however, may be approximately done in connection with observations made by the United States Fish

Commission. It must be borne in mind, in this connection, that the seasons south of Cape Cod begin earlier and last longer than in Massachusetts Bay, and that further north they will be still more contracted. Variation must also be expected in different years, as the seasons are earlier or later, and in different localities, as the waters are warmer or colder. Though the bulk of the laying or of the hatching in any particular year occurs within periods of two or three weeks, probably four-fifths of either is finished in less than a fortnight; to make allowance for the early years and for the late ones, and to include the early and the belated individuals, it becomes necessary to considerably extend the general periods.

From all that has been gathered we may summarize as follows: (1) The female lobster lays eggs but once in two years, the layings being two years apart; (2) the normal time of laying is when the water has reached its summer temperature, varying in different seasons and places, the period extending from about the middle of June till about the first of September; and (3) the eggs do not hatch before the summer following that in which they were laid, the time of hatching varying with the temperature, and the period extending from about the middle of May till about the first of August.

I have the honor to be, very respectfully yours,

S. Garman.

This represents all that is known of the life-history of the lobster to-day. Our plants from the eggs taken July 8, 1892, were made on July 12, 18 and 20, and was probably the last of the eggs laid the summer before. I do not believe that "the lobster lays eggs all the year round," as has been said. The animal leaves the "crawls" in cold weather and seeks a depth where the temperature is higher, and the lobstermen shift their pots in accordance with this migration.

In a two-column article the *Scientific American* of April 9, 1892, went over this subject, and from that I make the following extracts:

During the past ten years there has been a great falling off in the supply of lobsters, until the price has increased fully one hundred per cent. This applies alike to the New York market, to the waters along the New England coast and in Canada and Newfoundland, where lobster fishing and canning is an important industry. The necessity for increasing the supply of lobsters is generally recognized, and two methods are proposed for accomplishing this object. One is the enactment of laws which will check the depletion of the lobster beds by over-fishing and the other is artificial propagation.

Marshall McDonald, who is at the head of the United States Fish Commis-

sion, says: "I have always felt that the maintenance of the lobster fishery rested more essentially upon proper regulation of the matter by the States than upon any efforts in the way of artificial propagation. The most usual regulation is that prohibiting the sale of lobsters below certain dimensions; the minimum limit, though varying with the different States, being smallest in Massachusetts. In Maine, where the law is enforced and the minimum fixed, I believe, at ten inches, the result has been a marked improvement in the lobster fisheries during recent years."

A law was enacted by the New York Legislature in 1880, prohibiting the taking of lobsters smaller than ten and a half inches, but it was repealed, largely it is said, by reason of the efforts of a hotel keeper in New York city with political influence, who was determined to serve small lobsters on his table, regardless of the effect of rescinding the regulations.

The difficulty of securing legislation on this subject of enforcing the laws when they are enacted, and preventing their repeal through the efforts of persons who have no regard whatever for the consequences of their acts, compels those who desire to see the supply of this wholesome food fish kept up, to look to artificial propagation as the most available method for securing the object desired.

For three seasons lobsters have been hatched in small numbers at the station of the New York Commission, Cold Spring Harbor, L. I. The embryos are very delicate, and when lobsters are placed on ice, as many are which come to market, the embryo is generally ruined for hatching purposes.

Fred Mather, Superintendent of the Cold Spring hatchery, and a man of wide experience in fish propagation, said recently that lobsters were not only decreasing in numbers, but also in size. A two-pound lobster was now considered a fair average.

New York is next to the largest receiving market for lobsters in the country, yet the lobster fisheries within the boundaries of the State are not now important, and are confined to eastern Long Island. In former years lobsters were found in large numbers in New York Bay and at Hell Gate. The disappearance of this food fish is due mainly to over-fishing, but also to the establishment of manufactories, which have polluted the waters. Lobsters were taken at Robbin's Reef, New York Bay, as late as 1879, but they were small and were not exposed for sale.

Lobsters are sold in New York during the entire year, but the demand is five times greater during July, August and September than during any other three months of the year. The demand is the least during February and March. The consumption of lobsters at Coney Island in summer reaches 3,500 pounds a day.

The experience on the coast of Maine seems to be similar to that already stated. In 1890 twenty millions of lobsters were taken, which was a falling off of five millions or twenty per cent. from the catch of 1888 and ten per cent. from 1889. There has also been a steady decrease in the size of the fish sent to market. During 1889 and 1890 the average length of lobsters offered for

sale was 10½ inches, and the average weight two pounds. Ten years ago the average length was 13 inches and the weight three and one-half to four pounds. There are thirty-six factories on the coast of Maine where lobsters, sardines, herrings and mackerels are packed.

When it is remembered that the eggs which we get would be sent to market, boiled with the lobsters and thrown away with the shells, it will be seen what may be done in lobster culture with proper facilities. The lobster is easier to catch than a rabbit, for it has less sense, and when it sees a lobster pot with its bait, it seems to have found a haven of rest—and it has.

The decrease of the number of lobsters from Newfoundland to New Jersey, has been accompanied by a decrease in size, and a corresponding increase in price per pound. In proof of this I will again quote from the *Scientific American:*

The depletion of the lobster fisheries has been especially noticeable in Canada. The report of 1888 showed a decrease in the value of exports of $350,000, as compared with the previous year, although there had been an advance in the price of 25 per cent. The value of the Canadian lobster fishery in 1888 was $1,483,388; in 1886, $2,638,394; in 1885, $2,613,731.

Could figures speak plainer than these?

Up to June 11, this year, we have planted 85,350 young lobsters, and have on hand 510,000 eggs.* We cannot keep the young many days, because they are cannibals, and as they moult about three times in the first ten days and are then soft, their brethren devour them. I have fed them crab and lobster meat, clams and beef, with the hope of bribing them to refrain from eating their fellows, but did not succeed. They are persistent cannibals and must be put out at a few days old on rocky bottom, where there are always hiding places for a soft lobster to remain until his skin hardens into a new and larger shell.

*The plant for the year 1893, was 176,945. Most of the late eggs did not hatch.—F. M.

CONSTITUTION.

ARTICLE I.

NAME AND OBJECTS.—The name of this Society shall be "The American Fisheries Society." Its object shall be to promote the cause of fishculture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of the interests of fishculture and the fisheries; and the treatment of all questions regarding fish of a scientific and economic character.

ARTICLE II.

MEMBERS.—Any person shall, upon a two-thirds vote and the payment of three dollars, become a member of this Society. In case members do not pay their fees—which shall be three dollars per year—after the first year, and are delinquent for two years, they shall be notified by the Treasurer, and if the amount due is not paid within a month thereafter, they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote the of members present, at any regular meeting.

ARTICLE III.

OFFICERS.—The officers of this Society shall be a President and a Vice-President, who shall be ineligible for

election to the same office until a year after the expiration of their terms; a Corresponding Secretary, a Recording Secretary, a Treasurer, and an Executive Committee of seven, which with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

ARTICLE IV.

Meetings.—The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or in default of such action, by the Executive Committee.

ARTICLE V.

Changing the Constitution.—The Constitution of the Society may be amended, altered, or repealed, by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said meeting.

MEMBERS

OF THE

AMERICAN FISHERIES SOCIETY.

Honorary Members.

Behr, E. von Schmoldow, Germany; President of the Deutschen Fischerei verein, Berlin, Germany.

Borodine, Nicholas, Delegate of the Russian Association of Pisciculture and Fisheries, St. Petersburg, Russia.

Borne, Max von dem, Berneuchen, Germany.

Huxley Prof. Thomas H., London; President of the Royal Society.

Jones, John D., 51 Wall Street, New York.

St. Clair Flats Shooting and Fishing Club, Detroit, Mich.

Anglers' Association of Eastern Pennsylvania.

Corresponding Members.

Apostolides, Prof. Nicoly Chr., Athens, Greece.

Buch, Dr. S. A., Christina, Norway; Government Inspector of Fisheries.

Birkbeck, Edward, Esq., M. P., London, England.

Benecke, Prof. B., Conigsberg, Germany; Commissioner of Fisheries.

Brady, Thomas F., Esq., Dublin Castle, Dublin, Ireland; Inspector of Fisheries for Ireland.

Chambers, Oldham W., Esq., Secretary of the National Fishculture Association, South Kensington, London.

Day, Dr. Francis F. L. S., Kenilworth House, Cheltenham, England, late Inspector-General of Fisheries for India.

Fedderson, Arthur, Viborg, Denmark.

Giglioli, Prof. H. H., Florence, Italy.

Hubrecht, Prof. A. A. W., Utrecht, Holland: Member of the Dutch Fisheries Commission, and Director of the Netherlands Zoological Station.

Ito, K. Esq., Hokkaido, Cho., Sapporo, Japan; Member of the Fisheries Department of Hokkaido, and President of the Fisheries Society of Northern Japan.

Juel, Capt. N., R. N., Bergen, Norway; President of the Society for the Development of Norwegian Fisheries.

Landmark, S., Bergen, Norway; Inspector of Norwegian Fresh Water Fisheries.

Lundberg, Dr. Rudolph, Stockholm, Sweden; Inspector of Fisheries.

Macleay, William, Syndey, N. S. W.; President of the Fisheries Commission of New South Wales.

Maitland, Sir J. Ramsay Gibson, Bart., Howietown, Stirling, Scotland.

Malmgren, A. J., Prof., Helsingfors, Finland.

Marston, R. B., Esq., of London, England; Editor of the *Fishing Gazette.*

Olsen, O. T., Grimsby, England.

Sars, Prof. G. O., Christina, Norway; Government Inspector of Fisheries.

Smith, Prof. F. A., Stockholm, Sweden.

Sola, Don Francisco, Garcia, Madrid, Spain; Secretary of the Spanish Fisheries Society.

Solsky, Baron N. de, St. Petersburg, Russia; Director of the Imperial Agricultural Museum.

Trybom, Filip, Dr., Stockholm, Sweden.

Walpole, Hon. Spencer, Governor of the Isle of Man.

Wattel, M. Raveret, Paris, France; Secretary of the Societie d'Acclimation.

Young, Archibald, Esq., Edinburgh, Scotland; H. M. Inspector of Salmon Fisheries.

New Members.

Armstrong, C. E., Toledo, Ohio.
Blair, Joseph H., Omaha, Nebraska.
Davis, H. W. Detroit, Michigan.
Dean, Dr. Bashford, Columbia College, N. Y.
Jones, Alexander, Wood's Holl, Mass.
Ravenel, W. de C.

Members.

Adams, Edwin W., 14 Wall Street, New York.
Adams, Dr. S. C., Peoria, Ill.
Agnew, John T., 284 Front Street, New York.
Alexander, L. D., P. O. Box 897, New York.
Amsden, F. J., Rochester, N. Y.
Anderson, A. A., Bloomsbury, N. J.
Anderson, J. F., Whitestone, Long Island, N. Y.
Annin, James, Jr., Caledonia, N. Y.
Atkins, Charles G., Buckport, Me.
Atwater, Prof. W. O., Middleton, Conn.
Ayers, F. W., Bangor, Me.
Babcock, C. H., Rochester, N. Y.
Balkam, William F., Rochester, N. Y.
Banks, Robert Lenox, Albany, N. Y.
Barnum, William, Rochester, N. Y.
Barrett, Charles, Grafton, Vt.
Bartlett, S. P., Quincy, Ill.

Bean, Dr. Tarleton H., National Museum, Washington.
Belmont, Perry, 19 Nassau Street, New York.
Benjamin, Pulaski, Fulton Market, New York.
Benkard, James, Union Club, New York.
Bickmore, Prof. A. S., American Museum, New York.
Bishop, M. D., Heber, 380 Newbury Street, Boston, Mass.
Bissell, J. H., Detroit, Mich.
Blackford, E. G., Fulton Market, New York.
Booth, A., Chicago, Ill.
Bottemane, C. J., Bergen-on-Zoom, Holland.
Bower, Seymour, Deerfield, Mich.
Bowman, W. H., Rochester, N. Y.
Bradley, Dr. E., 19 West 30th Street, New York.
Brown, F. W., N. W. corner Broad and Cherry Streets.
Brown, J. E., U. S. Fish Commission, Washington, D. C.
Brown, S. C., National Museum, Washington, D. C.
Brush, M. D., Edward F., Mount Vernon, N. Y.
Bryan, Edward H., Smithsonian Institute.
Bryson, Col. M. A., 903 Sixth Avenue, New York.
Buell, H. S., Fishing Editor, *Times Union*, Albany, N. Y.
Burden, Henry, Troy, N. Y.
Butler, W. A., Jr., Detroit, Mich.
Butler, Frank A., 291 Broadway, New York,
Butler, W. H., 291 Broadway, New York.
Carey, Dr. H. H., Atlanta, Ga.
Chamberlayne, Chas. F., Buzzards Bay, Mass.
Cheney, A. Nelson, Glen Falls, N. Y.
Clapp, A. T., Sunbury, Pa.
Clark, Frank N., U. S. Fish Commission, Northville, Mich.
Clark, A. Howard, National Museum, Washington, D. C.
Collins, J. Penrose, 850 Drexel Building, Philadelphia.
Collins, Capt. J. W., U. S. Fish Commission, Washington.
Comstock, Oscar, Fulton Market, New York.
Conklin, William A., Central Park, New York.
Cox, W. V., National Museum, Washington, D. C.
Crook, Abel, 99 Nassau Street, New York.

Crosby, Henry F., P. O. Box 3714, New York.
Dewey, J. N., Toledo, Ohio.
Dieckerman, Geo. H., New Hampton, N. H.
Donaldson, Hon. Thomas, Philadelphia.
Doyle, E. P., Secretary New York Fish Commission, New York.
Dunning, Philo, Madison, Wis.
Earll, R. E., National Museum, Washington, D. C.
Ellis, J. F., U. S. Fish Commission, Washington, D. C.
Endicott, Francis, Tompkinsville, N. Y.
Evarts, Charles B., Windsor, Vt.
Fairbank, N. K., Chicago, Ill.
Ferguson, T. B., Washington, D. C.
Fitzhugh, Daniel H., Bay City, Mich.
Foulds, M. D., T. H., Glen Falls, N. Y.
Foord, John, Brooklyn, N. Y., Editor *Harper's Weekly*.
Ford, Henry C., Philadelphia, Pa.
French, Asa B., South Braintree, Mass.
Frishmuth, E. H., Jr., 151 N. Third Street, Philadelphia.
Garitt, W. S., Lyons, N. Y.
Garman, S., Museum of Comparative Zoölogy, Cambridge, Mass.
Garrett, W. E., P. O. Box 3006, New York.
Gay, John, U. S. Fish Commission, Washington, D. C.
Gilbert, W. L., Plymouth, Mass.
Goode, G. Brown, National Museum, Washington, D. C.
Greuseback, Jas. A., New Rochelle, N. Y.
Gunckel, J. E., Toledo, Ohio.
Hackney, David D., Fort Plain, N. Y.
Hagert, Edwin, 32 N. Sixth Street, Philadelphia.
Haley, Albert, Fulton Market, New York.
Haley, Caleb, Fulton Market, New York.
Hall, A. G., Reeds Creek, Delaware Co., N. Y.
Hamilton, Robert, Greenwich, N. Y.
Harper, Thos. B., 709 Market Street, Philadelphia.
Harris, Gwynn, Washington, D. C.

Harris, W. C., Editor *American Angler*, 10 Warren Street, New York.
Hartley, R. M., 627 Walnut Street, Philadelphia.
Hasbrouck, C. T., Cleveland, Ohio.
Hayes, A. A., Washington, D. C.
Hayes, W. H., Ottowa, Canada.
Henshall, Dr. J. A., 362 Court Street, Cincinnati, Ohio.
Hergesheimer, Wm. S., 1119 N. Eight Street, Philadelphia.
Hessel, Dr. Rudolph, U. S. Fish Commission, Washington.
Hicks, John D., Roslyn, Long Island, N. Y.
Hill, M. D., Clayton, N. Y.
Hinchman, C. C., Detroit, Mich.
Hofer, J. C., Bellaire, Ohio.
Hoxie, John W., Carolina, R. I.
Hudson, Dr. Wm. M., Hartford, Conn.
Hughes, T. W. B., 258 Broadway, New York.
Humphries, Dr. E. W., Salisbury, Md.
Huntington, L. D., New Rochelle, N. Y.
Huntington, W. R., Cleveland, Ohio.
Hutchinson, Chas., Utica, N. Y.
Hutchinson, E. S., Washington, D. C.
Isaacs, Montefiore, 42 Broad Street, New York.
Imbrie, Charles F., New York.
James, Dr. Bushrod W., N. E. corner Eighteenth and Green Streets, Philadelphia.
Jessup, F. J., 88 Cortlandt Street, New York.
Johnston, S. M., Battery Wharf, Boston, Mass.
Jones, R. W., President Mentfrede Fishing Club, Syracuse, New York.
Jones, R. W., President Carpenter Brook Fishing Association, Syracuse, N. Y.
Kauffman, S. H., *Evening Star* Office, Washington, D. C.
Kellogg, A. J., Detroit, Mich.
Kelly, P., 346 Sixth Avenue, New York.
Kimball, W. J., Rochester, N. Y.
Kingsbury, Dr. C. A., 1119 Walnut St., Philadelphia, Pa.

Klock, George S., Rome, N. Y.
Krumbholtz, T. Edmund, Wawbeck, N. Y.
Lamtson, Giles H., U. S. Fish Commission, Washington.
Lawrence, G. N., 45 E. Twenty-first Street, New York.
Lawrence, F. C., Union Club, New York.
Leavenworth, E. W., Wilkesbarre, Penn.
Lee, Thomas, U. S. Fish Commission.
Little, Amos R., Philadelphia.
Loring, John A., 3 Pemberton Square (Room 8), Boston, Mass.
Lowrey, J. A., Union Club, New York.
Lydecker, Major G. I., U. S. Engineers.
Lynch, Peter W., New York.
Mallory, Charles, foot Burling Slip, New York.
Mansfield, Lieut. H. B., U. S. Navy, Washington, D. C.
Marks, Walter D., Paris, Mich.
Mather, Fred., Cold Spring Harbor, Suffolk Co., N. Y.
May, W. L., Fremont, Neb.
McDonald, Col. L., Fish Commissioner of the United States, Washington, D. C.
McGown, Hon. H. P., 76 Nassau Street, New York.
Mackay, Robert M., 1517 N. Thirteenth Street, Philadelphia.
Merrill, Ph. D., Frederick J. H., State Museum, Albany, New York.
Middleton, W., Fulton Market, New York.
Milbank, S. W., Union Club, New York.
Miles, Jacob F., 1820 Arch Street, Philadelphia.
Miller, S. B., Fulton Market, New York.
Miller, Ernest, Fulton Market, New York.
Miller, Joseph O., Mount Kisco, N. Y.
Miller, A. H., 1020 Spring Garden Street, Philadelphia, Pa.
Mills, George T., Carson City, Nevada.
Miner, C. Harry, New York.
Mitchell, Archibald, Norwich Conn.
Moon, George T., New York.
Moore, Geo. H. H., U. S. Fish Commission.

Morrell, Daniel, Hartford, Conn.
Nevin, James, Madison, Wis.
O'Brien, Martin E., South Bend, Neb.
O'Connor, J. J., U. S. Fish Commission, Washington, D. C.
Offensend, John H., Fair Haven, Vt.
Osborn, Hon. C. V., Dayton, Ohio.
Orvis, Charles F., Manchester, Vt.
Page, W. F., U. S. Fish Commission, Washington, D. C.
Parker, Dr. J. C., Grand Rapids, Mich.
Parker, Peter, Jr., U. S. Fish Commission.
Pease, Charles, East Rockport, Cuyahoga Co., Ohio.
Pike. Hon. R. G., Middleton, Conn.
Porter, B. P., San Francisco.
Post, Hoyt, Detroit, Mich.
Post, W., Knickerbocker Club, New York.
Potter, Emory D., Sandusky, Ohio.
Powell, W. L., Harrisburg, Pa.
Powers, J. A., Lansingburg, N. Y.
Puston, Dr. Henry G., 98 Lafayette Ave., Brooklyn.
Quackenbos, Prof. John D., 33 West Twenty-eighth Street, New York.
Rathburn, Richard, U. S. Fish Commission, Washington.
Ray, Hon. Ossian, M. C., New Hampshire.
Redmond, R., 113 Franklin Street, New York.
Reinecke, Theodore, Box 1651, New York.
Reynal, J., 84 White Street, New York.
Reynolds, Charles B., 318 Broadway, New York.
Ricardo, George, Hackensack, N. J.
Robeson, Hon. George M., Camden, N. J.
Rogers, W. H., Amherst, N. S.
Sarnaca Lake Hotel Co., Patton & Young, Ampersand, Franklin Co., N. Y.
Schaffer, George H., Foot Perry Street, New York.
Schieffelin, W. H., 170 William Street, New York.
Schuyler, H. P., Troy, N. Y.
Seal, William P., Washington, D. C.

Sherman, Gen. R. U., New Hartford, Oneida Co., N. Y.
Sherwin, H. A., Cleveland, Ohio.
Simmons, Newton, U. S. Fish Commission, Washington.
Smiley, C. W. Smithsonian Institute, Washington, D. C.
Smith, Hugh M., Washington, D. C.
Spangler, A. M., 529 Commerce Street, Philadelphia.
Spensley, Calvert, Mineral Point, Wis.
Spofford, Henry W., Smithsonian Institute.
Stelwagon, Weightman, 702 Provident Building, Philadelphia.
Steers, Henry, 10 E. 38th Street, New York.
Stone, Livingston, Charlestown, N. H., U. S. Fish Commission.
Stone, Summer R., 58 Pine Street, New York.
Stranahan, J. J., Chagrin Falls, Ohio.
Swan, B. L., Jr., 5 West 20th Street, New York.
Sweeney, Dr. R. O., Duluth, Minn.
Streuber, Louis Erie, Pa.
Taylor, Alex. Jr., Mamaroneck, N. Y.
Thompson, H. H., Bedford Bank, Brooklyn, N. Y.
Titcomb, John W., Rutland, Vt.
Tomlin, David W., Duluth, Minn.
Underhill, John Q., New Rochelle, N. Y.
Upston, Geo. W., Warren, Ohio.
Van Cleef, J. S., Poughkeepsie, N. Y.
Van Valkenburgh, B. F,. 288 Greenwich Street, New York.
Walton, Collins W., 1713 Spring Garden Street, Philadelphia.
Ward, George E., 43 South Street, New York.
Ward, M. D., Samuel R., Pres't Eastern New York Fish and Game Association.
Warren, C. C., Waterbury, Vt.
Webb, W. Seward, 44th Street and Vanderbilt Ave., New York.
Weeks, Seth, Corrie, Erie Co., Pa.
Welshons, G. H., *Pittsburg Times*' Office, Pittsburg, Penn.

West, Benjamin, Fulton Market, New York.
Whitaker, Herschel, Detroit, Mich.
Whitaker, E. G., New York City.
Wilbur, E. R., *Forest and Stream*, New York City.
Wilbur, H. O., Third St., below Race, Philadelphia.
Willetts, J. C., Skaneatles, N. Y.
Witherbee, W. C., Port Henry, Essex Co., N. Y.
Yalden, James, 11 Pine Street, New York.
Zweighalt, S. 1323 Franklin Street, Philadelphia.

Division of Fishes,
U. S. National Museum

American Fisheries Society.

1894.

Smithsonian Institution
JUN 25 1920
National

TRANSACTIONS

OF THE

AMERICAN

FISHERIES SOCIETY.

TWENTY-THIRD ANNUAL MEETING.

.... HELD IN ....

PHILADELPHIA,

Wednesday, May 16th and Thursday, May 17th, 1894.

NEW YORK:
THOS. HUMPHREY, Printer, 359 Canal St.
1894.

Officers for 1894-'95.

PRESIDENT, W. L. MAY.....*Nebraska.*

VICE-PRESIDENT, R. O. SWEENY.....*Minnesota.*

TREASURER, FRANK J. AMSDEN.....*New York.*

RECORDING SECRETARY, EDWARD P. DOYLE... *New York.*

COR. SECRETARY, DR. JAMES A. HENSHALL.....*Ohio.*

Executive Committee.

H. H. CARY,.....*Georgia.*

L. D. HUNTINGTON,.....*New York.*

HENRY C. FORD.....*Pennsylvania.*

CALVERT SPENSLEY.....*Wisconsin.*

CHARLES L. CHAMBERLAYNE,.....*Massachusetts.*

HOYT POST,.....*Michigan.*

MINUTES

—OF THE—

TWENTY-THIRD ANNUAL MEETING

—OF THE—

AMERICAN FISHERIES SOCIETY,

HELD IN

PHILADELPHIA,

WEDNESDAY, MAY 16TH AND THURSDAY, MAY 17TH, 1894.

The meeting was called to order at ten o'clock A. M. by the President, Henry C. Ford of Pennsylvania. The following members were present:

A. M. Spangler, H. C. Ford, Wm. E. Meehan, B. W. James, W. L. May, Wm. H. Bowman, Robert Hamilton, Fred. Mather, C. F. Chamberlayne, Herschel Whitaker, John Gay, L. D. Huntington, Edward P. Doyle, Howard A. Chase, H. H. Cary, M. D., F. W. Ebel, J. W. Collins, Marshal McDonald, F. H. Bean, Richard Rathburn, M. D. Cornwall, William L. Taylor, M. D., W. S. Andrews, J. S. Van Cleaf, H. Van Cleaf, H. A. Wilbur, F. Ellis, B. L. Douredoure, A. H. Miller, W. L. Powell.

On motion, the calling of the roll was postponed

until the afternoon. A telegram was received from R. O. Sweeny, Treasurer of the Society, announcing that it would be impossible for him to be present at the meeting and sending a statement of his account.

On motion, John Gay of Pennsylvania was appointed Treasurer pro tem.

The minutes of the last meeting having been printed in the report as published, on motion, the reading of the minutes was dispensed with.

The President appointed the following committee on nominations of officers for the ensuing year; W. L May of Nebraska, Herschel Whitaker of Michigan, H. H. Cary of Georgia, John Gay of Pennsylvania and William H. Bowman of New York.

Dr. B. W. James of Pennsylvania, H. H. Cary of Georgia and W. L. May of Nebraska, were appointed a committee to audit the accounts of the Treasurer.

On motion, a Committee of three was appointed to determine the time and place of the next meeting. The President appointed as such Committee W. L. May of Nebraska, L. D. Huntington of New York and B. W. James of Pennsylvania.

On motion, the following gentlemen being duly nominated and seconded, were unanimously elected members of the Society:

Howard A. Chase of Philadelphia, William E. Meehan of Philadelphia and William T. Wardle of New York.

The President, Mr. Ford, then addressed the Society at length upon its work.

A paper was read by Fred. Mather on "Improved Methods of Hatching Smelt."

A paper was read by Dr. B. W. James on "Alaskan and Behring Sea Fishing Interests."

A paper was read by Charles Hallock, entitled "When Shad were a penny a piece."

Mr. Doyle offered the following resolution :

RESOLVED. That the President appoint a Committee of three on Increase of Membership, such Committee to have full power to solicit eligible persons to join the Society ; subject, however, to the right of the Society to reject or elect such persons to membership.

The motion was pending when the motion to adjourn was made and carried, and the convention adjourned to meet at two o'clock in the afternoon.

Minutes of adjourned meeting held Wednesday, at two o'clock in the afternoon.

The pending question, being the resolution providing for a Committee of three on Increase of Membership, was put and carried. The President appointed as such Committee, Edward P. Doyle of New York, Herschel Whitaker of Detroit, Michigan, and W. L. Powell of Harrisburg, Pennsylvania.

A paper was read by Herschel Whitaker on "The Artificial Propagation of Black Bass."

A paper was read by Tarlton H. Bean on "The White Fish."

A paper was read by Col. Marshal McDonald, United States Fish Commissioner on "The Relation of the Fisheries to the Community."

Col. Marshal McDonald invited the members of the Society to a trip down the river on the United States

Fish Commission Steamer "Fish-Hawk," and placed the steamer at the disposal of the Society.

The President, in the name of the Society, thanked Mr. McDonald cordially for his invitation and accepted it.

A paper was read by Livingstone Stone on the "Non-Feeding Habits of Chinook Salmon."

A paper was read on "Handling of Adhesive Eggs," by J. J. Stranahan.

On motion, meeting adjourned to meet Thursday, May 17th, at ten o'clock.

MEETING WAS CALLED TO ORDER PROMPTLY AT TEN O'CLOCK.

A resolution was passed, thanking the Pennsylvania Fish Commission and the Protective Association of Philadelphia for their kindness in providing an entertainment for the delegates.

On motion, the Secretary was directed to enter upon the minutes of the meeting an expression of the Society's thanks to Col. Marshal McDonald for his kindness in putting the steamer Fish-Hawk at the disposal of the Society.

The following resolution was offered by Secretary Doyle, and unanimously adopted :

WHEREAS, the proceedings of this meeting have been fully and accurately reported in the press of this city, therefore be it

RESOLVED, that the thanks of the Society be tendered to the newspapers of the City of Philadelphia for their kind appreciation of the importance to the

people generally of the interest the Society represents and the consideration the press has given to the reports of its proceedings.

The Secretary offered the following resolution, which, upon motion, was unanimously adopted.

RESOLVED, that the Committee on Increase of Membership be requested to invite all Fish Protective Associations of the United States to join the American Fisheries Society, on payment of Three Dollars each for annual dues, such membership to entitle the said associations to representation by one delegate at the annual meetings of the Society.

The Committee on Nominations presented the following report :

To the Members of the American Fisheries Society:

Gentlemen :—Your Committee on Nominations, to whom was referred the matter of reporting candidates for the various officers of the Society, have met and considered the matter referred to them, four members of the Committee being present, Mr. May not sitting, and have directed me to make the following report.

For President, W. L. May of Nebraska; for Vice-President, R. O. Sweeny of Minnesota; for Treasurer, Frank J. Amsden of New York; for Recording Secretary, Edward P. Doyle of New York; for Corresponding Secretary, Dr. James A. Henshall of Ohio.

Executive Committee, H. H. Cary of Georgia, L. D. Huntington of New York, Henry C. Ford of Pennsylvania, Calvert Spensley of Wisconsin, Charles

L. Chamberlayne of Massachusetts, and Hoyt Post of Michigan, all of which is respectfully submitted.

On motion, the report was received and unanimously adopted, and the officers declared elected for the ensuing year.

The Committee on Place and Time of Next Meeting reported in favor of meeting in the city of New York, on the second Wednesday of June, 1895.

On motion, report was adopted.

On motion, the following resolution was adopted :

RESOLVED, that the Secretary of the Society be directed to enter upon the minutes of the meeting an expression of the thanks of the delegates present to the members of the Pennsylvania Fish Commission and Pennsylvania Fish Protective Association for the generous entertainment provided to the members of the Society attending this meeting.

REPORT OF RECORDING SECRETARY.

GENTLEMEN :

The writer of this, although elected Recording Secretary at the meeting held in Chicago, in 1893, never accepted the office, and the question of determining his successor was referred, with power, to the Executive Committee although no action was taken by that body. This statement is made partly as an apology for what may have seemed to the members careless and negligent management of his office by the Recording Secretary. Publication and delivery of the report was delayed and a number of matters of importance given insufficient attention. As a partial result of this inattention to business the membership of the Society has not increased, the total active membership remaining at about 200, and with an active Recording Secretary the membership of this Society could be easily increased to 2,000 or 3,000 persons, and the sphere of its influence and importance enormously extended. The result of some work done in 1892 convinces me of this. At that time I succeeded in inducing every Fish Commissioner of the United States to join this Society, and I am satisfied that by faithful work every Fish Protective Association of the United States would have at least one representative in our Association. This would give us an influential and extensive membership, powerful and good for securing desired protective legislation and in educating public sentiment so that such legislation might be thoroughly enforced. The annual meetings of such a Society, with delegates representing well organized local Societies throughout the United States, would attract great attention and the result of its deliberations be of the utmost weight. In view of the growing interest of the people in matters relative to fish

cultivation and protection and the increasing public appreciation of the economic value of the work of the State and National Commissions, it seems to me that an attempt should be made to have this Society made the mouth-piece and representative of this aroused public sentiment. The people then speaking through an organized body could express more clearly what was needed to protect the fish and game, and such an expression would have more weight than coming from an individual or local association. If the American Fisheries Society could be made a strong central organization, as I have suggested, we would have an association whose influence upon all questions affecting this most important subject (the maintenance of one of the great sources of the food supply of the people) would be all powerful. The suggestions of such an organization would never be slighted and its recommendations would be welcomed and adopted. I have prepared and will submit for the consideration of the Society a resolution providing for a committee of three who shall be charged with securing an increased membership for this Society. This committee to have power to send out circulars and to form other committees, and to do everything it may deem necessary to secure members subject, of course, to the right of the Society to accept or reject any applicant for membership.

Very respectfully,

EDWARD P. DOYLE.

TREASURER'S REPORT.

R. O. Sweeny, Sr.

IN ACCOUNT WITH

American Fisheries Society

1893.	Dr.		
July 20.	To check from H.C. Ford	$126.86	
Dec. 28.	To membership dues paid in to date	159.00	
1894.			
May 14.	Membership dues collected up to date	138.00	
			$423.86
1893.	Cr.		
July 31.	Postage Stamps	$ 3.00	
Aug. 7.	H. C. Lemaer Bros., N. Y., Circulars, Etc.	16.65	
Aug. 21.	Stamps	1.00	
Sept. 13.	"	1.00	
" "	Collection on checks	.20	
" "	J. J. Le Tourneau, printing bills and envelopes	4.00	
Oct. 3.	H. Whitaker, Stenography Chicago meeting	20.00	
Nov. 2.	Stamps	1.00	
" 16.	Express charge on Pamphlets	1.15	
" 17.	Jno. M. Davis, printing reports	278.50	
	Express charge	.25	278.75

1894.		
	Stamps.....	3.00
April 17	May Flint, N. Y., Stenography.....	14.62
" 20.	Stamps.....	1.00
" "	J. J. Le Tourneau, Printing	1.00
" "	J. L. Coffey, N.Y., preparing report.....	10.00
	Cash on hand.....	67.49
		$423.86

R. O. SWEENY, Sr., Treasurer.

DULUTH, MINN.,
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H. H. CARY, *Auditing Committee.*

ADDRESS OF THE PRESIDENT.

Gentlemen of the American Fisheries Society:

When your society met in these rooms in 1889, the organization that then extended to you its welcome was desiginated "The Anglers' Association of Eastern Pennsylvania." A broader view, however, of the work confronting them in their State, prompted a change of name to "The Pennsylvania Fish Protective Association." Under this title the work commenced by its members as anglers for the perpetuation and increase of fish in Pennsylvania for purposes of sport has been raised to the higher and nobler plans of propogating and protecting the supply of food and game fish for the benefit of the people. And for this end it has sedulously labored and steadily impressed upon Fish Commissioners and legislatures the fulfillment of its motto "The enforcement of the laws and the protection of the spawning fish." This statement, however, implies nought that is derogatory to the angling fraternity, for from the anglers came the first fish culturists. Seth Green and Thaddeus Norris learned first to cast the fly before they delved into the mysteries of hatching boxes.

And even at this late day, our anglers, men of close observation, whose calling renders them familiar with the habits of fish, can often correct errors that ichthyologists and fish culturists sometimes erroneously promulgate. As an instance, a fish cultural article relative to shad appeared a few years ago stating that shad always spawned between nine and twelve at night. A thoughtful man might well have wondered how any fish culturist could discern spawning shad in these dark hours, but it was reserved to an observant angler on the Upper Delaware to utterly disprove this theory and show that shad spawned in broad daylight.

In drifting over the quiet eddies of the river, he had looked down into the clear waters and there above the gravel bars had seen the exudation and impregnation of spawn, a sight than can be witnessed any day during the shad season on the Upper Delaware.

The continuous testimony of anglers against the introduction of foreign fish into our waters, and especially into our trout streams, is also bearing its fruit in the recommendation of our State Commissioners to plant no foreign trout in the native trout streams, for if the anglers are to be trusted, and there is no reason to doubt their opinion, our native brook trout are far superior in edible and gamey qualities to the foreign importations, and therefore as the best fish they are *best* for the streams.

Our angling friends say also that the European Carp is fast becoming a nuisance in many of our waters, and though coming with the reputation of a vegetarian, labors under the imputation of devouring the spawn and sometimes the young of better fish.

On this, the twenty-third annual meeting of your Society, it might be well to take a brief retrospect of the past.

When this society was formed in 1870, fish cultural operations were in their infancy. The Michigan Commission that now pours its millions of white fish and pike perch fry into the surrounding great lakes, was not created until 1871, a year later. The New York Commission was in a similarly inchoate state. The Pennsylvania Commission was just beginning to have its conception in the brains of a few enthusiastic anglers, so that the first meeting of the Society was composed not mostly of Fish Commissioners, as at the present, but of the Fish Culturists, and by them was named the American Fish Culturists Association. In 1878 this title was changed to that of the American Fish Cultural Association, and in 1884 to the American Fisheries Society, which name it has since retained.

Probably there is no better way of measuring the progressive strides of fish culture in the United States than to take the single instance of a State like Pennsylvania.

Twenty-three years ago there was no trout hatchery in the State. The Fish Commission had just been created. About two thousand black bass were distributed in the larger Eastern rivers and streams, and with the aid of Seth Green a few hatching boxes for shad were at work in the Susquehanna and Delaware. But little restrictive legislation had been enacted, and even these protective laws were not enforced, for the people generally looked on the fishery laws as so many restrictions on personal liberty, and they were held in supreme disfavor.

Every stream in the State, from the Delaware and Susquehanna rivers down to the mountain trout streams, was filled with the deadly fish weirs that were rapidly depleting the waters of their supply of fish food ; and there was no restocking to restore the constant decrease of fish. People did not then pause to reflect that even as their land would be exhausted if the nutritive elements of the soil were not constantly renewed so the fruitfulness of the waters would become barren if their fish supply was not kept up. This was the condition of Pennsylvania waters in the early seventies, and for some years later ; for reform, especially when tardy and experimental, requires time for its successful developement.

It would be interesting, but too lengthy, to note the different processes of the gradual change that has restored to Pennsylvania her great shad fisheries of the Delaware, that has made the City of Erie one of the largest fish marts on the great lakes, and that has renewed her thousands of trout streams, for many of you may not be aware that Pennsylvania next to Maine has more trout streams, and more trout producing area, than any State in the Union.

It would be interesting to note the steady enactment

of restrictive laws, not without opposition, and to mark the contest of progress with ignorance and lawlessness, until to-day the fishery laws are respected where they were once set at nought.

Within the last three months, from our hatcheries thirty millions of white fish have gone into Lake Erie, eighty millions of wall-eyed pike have been deposited in the same lake, and in our larger rivers and streams. Over four million of the different varieties of trout have been placed in our streams. Five million of blue pike are hatching in the Erie Hatchery for the benefit of that lake, or a total of one hundred and nineteen millions of fish planted to replenish the food supply of the people, to say nothing of the millions of shad fry that during the season will be deposited by the United States Commission in the Delaware and Susquehanna, by our own hatching on the Upper Delaware.

Do not think, gentlemen of the American Fisheries Society, that these weighty statistics are mentioned boastfully, as showing what Pennsylvania has done, and leaving the inference that no other state has done as well. The history of Pennsylvania fish culture is likewise the history of Michigan, New York and Wisconsin fish culture. It is the history of the American Fisheries Society, for the men who are the members of this Society have made such statistics possible and practicable.

Yet, gentlemen, it would seem that this Society should have a greater work marked out for it than to merely meet once a year for the purpose of collating experiences and papers. Its influence should be felt where legislation beneficial to fish cultural interests is opposed by adverse influences. It should be a force in the condemnation of erroneous views; and should not hesitate to make itself heard where the expression of its opinion would be a potent factor in the determination of a correct course in fishery matters. With just and impartial decisions, and uncontrolled by faction, the American

Fisheries Society has before it a future, which if properly developed, will make it a power in fishery matters even greater than it has been in the past.

The Society is National in its membership and in its work, and fishery issues that are National should not be foreign to it. Its vigilance should extend not only over our inland lakes, our interior streams and rivers, but also to the broad Pacific and the nearer Atlantic, to correct abuses that clearly come within its province for vigorous condemnation.

HENRY C. FORD, President,

AMERICAN FISHERIES SOCIETY.

PAPERS READ BEFORE THE

American Fisheries Society,

WITH THEIR DISCUSSIONS.

WHEN SHAD WERE A PENNY A-PIECE.

BY CHARLES HALLOCK.

Every schoolboy knows in a general way that shad were once so abundant in the Connecticut river that hired men used to stipulate that they should be served with only a limited quantity per week for food, but I dare say few people, adolescent or adult, are aware that it was considered disreputable a century and a half ago to eat shad, and that the epithet of "shad-eater" was regarded as most obnoxious and opprobrious in New England.

Whether it was because shad were in common use by the vagabond Indians who occupied the valley, or because their very cheapness and abundance made them vulgar, history does not state. But it is of record that shad were overlooked, thrown out, and despised as food by a large proportion of the English occupants of the old towns for a period of one hundred years after their settlement. Only poor people ate shad in those days. Shad eating implied a deficiency of pork, and to be destitute of pork indicated poverty. Even now an apology is sometimes made when a family has no "meat,"

as pork was always designated. The story is told of a well-to-do family in Hadley, which was always an aristocratic town, who, hearing a knock at the door just as they were about to dine on this tabooed fish, incontinently hid the platter under the bed. Indeed, so ground into popular sensibility was this ancient prejudice, that as recently as forty years ago members of the Connecticut Legislature were sometimes taunted with the epithet of "shad eaters." The radical change of appreciation which has taken place since can be realized when we find these same people boasting now of the superlative quality of their shad as compared with all others in the market.

Not until forty years before the Revolution was this economic ban removed and shad became a merchantable commodity. Connecticut shad in barrels were first advertised in Boston in 1736, though they were current in river towns for at least three years previous at one penny a-piece. By 1773 prices had advanced to two or three pence, and in 1778 several thousand barrels were put up for the Continental troops. In 1779 the price reached four pence ha'penny, and after the dam was placed at South Hadley Falls in 1795 the number of shad in the river perceptibly diminished and the price gradually advanced to six pence, nine pence, one shilling, and then higher, until men ceased to buy shad to barrel for family use. Thenceforward they became a fancy fish and a luxury, even replacing the salmon, which had always maintained a high precedence, but had now also disappeared by reason of the dams which obstructed their ascent of the river.

Shad never passed the Bellows Falls, at Walpole, New Hampshire, nor the falls of the Chicopee river, in Massachusetts, though salmon surmounted both.

In 1739, according to Sylvester Judd, the historian, the town of Brookfield petitioned the General Court for leave to make a fishway for shad through the ledges of rocks across the Chicopee at Springfield, so that they might come up the river into the ponds, but Springfield

opposed, and permission was not granted. The burghers feel differently now. Until the erection of the dam at Holyoke in 1849 caused an effectual blockade, shad were fairly abundant in the lower reaches of the Connecticut and falls ; wherever they occurred were always chosen fishing places for both salmon and shad. Gangs of professional fishermen hired valuable seining privileges, and during the fishing season in April, May and early June, rival camps were often the scenes of much horse play and frolic at off hours. History tells how the farmers and netters used to gather from all parts of the adjacent valley, and even from Berkshire, to the number of 1,500 or more at a time, just as they gather now on the tributaries of the Columbia when salmon are running, or on the rivers of Nova Scotia for alewives and gaspereaux.

Since the construction of the Holyoke dam many efforts have been made to restock the Connecticut with salmon and shad, and with partial success as respects the latter. But it is very doubtful if its old prestige ever returns, and certain that shad will never again be sold for a penny a piece.

After the reading of this paper,

Mr. Ford said : "The lower part of the Delaware is so taken up with nets that the fish have very little chance to reach the spawning beds. In the upper part of the Delaware River the fish weirs cause a great deal of anxiety but we have at last secured legislation which has eradicated them. We have tried to secure reciprocal legislation between New York and New Jersey so that we can make it illegal to take shad on Saturday till twelve o'clock on Sunday, thus giving the shad one day to get up the river, but naturally we have been unsuccessful. There should be some means devised by which the shad could reach the spawning grounds in the upper part of the river. Now, gentlemen, the construction of

dams in the Delaware, River at Lackawaxen, has helped us very much, althought this is one hundred and forty miles above Philadelphia."

Dr. Cary, of Georgia, asked if there were several well authenticated instances where shad have passed up the fishways. He says, that it is known that other fish do, but as the shad is a very nervous and easily frightened fish, I do not believe that there are many instances where they have been known to pass up the fishway.

Mr. Ford said, "They have passed into New York in very large numbers and through the fishway in Lackawaxen Dam. If you will look into the '91 Report of the New York Fish Commission, you will find that one of the game and fish protectors states that he saw them in such large quantities that they completely covered the bottom of the river and were taken in large numbers."

Colonel Cary said that in Georgia the city of Augusta built a dam across the Savannah River. The people of South Carolina living above the dam protested against the building of the dam, and as a compromise six McDonald fishways were directed to be built in the dam. He had heard nothing from South Carolina since, but the people on the Georgia side above the dam complained that the fiishways were inoperative. He himself had visited every fishway in the northern and eastern states, but had never learned satisfactorily that shad had ascended them. There was no doubt in his mind as to their value to other fish, especially salmon, but he doubted whether fish as nervous and timid as shad are known to be, would ascend a fishway. He would like some authority to answer on the question, as the matter was being again agitated on the Georgia side of the Savannah River.

THE HANDLING OF ADHESIVE EGGS.

J. J. STRANAHAN, OF OHIO.

My excuse for preparing a paper on the handling of adhesive eggs must be the general interest taken among fish culturists in the subject, and the difficulty formerly experienced in this field. I however, have a purpose, slightly ulterior in its bearing, and that is to correct a statement made by Professor Jacob Reighard of Michigan, at the last meeting of the Association, as to my plan of handling the eggs of the pike perch. In his paper the Professor stated in substance that my mode of handling adhesive eggs is to permit them to form into a mass and then separate them by rubbing through a screen. Of course it will go without the saying that the Professor has been misinformed. Our plan is—or rather was—to work the eggs continually until the adhesive tendency has passed away, changing the water from time to time, placing them in fifteen gallon wooden tubs—the same used in collecting—on their arrival at the station, where for about twenty-four hours they are left in running water, the watchman stirring them from time to time, or at least once each half-hour.

At the end of the above named time the eggs are fully hardened and not liable to injury. They are then put through a wire screen admitting the passage of but one egg at a time through its meshes, the lumps remaining being rubbed through the screen with a large paint brush with long bristles.

Careful experiments have demonstrated that the eggs are not injured by this course, while if the lumps are permitted to go into the jars the eggs composing them are invariably lost through being carried over by the

formation of air or gas bubbles within the egg mass or through fungusing.

This process, although fairly successful, is very tedious, consuming much valuable time, when the spawn taker is most busy. Many experiments have therefore been made to prevent adhesion among the eggs by both chemical and mechanical means, among the pioneers in this field being Professor Reighard.

Following his directions this spring, I placed in the hands of Mr. John Dukes, one of our most experienced spawn takers, one quart of dry corn starch dissolved in five gallons of water and directed him to place therein, after impregnation and three minutes interval, one gallon of the eggs of the pike perch.

Believing that the Professor's plan might be improved upon, in another keg I placed finely dissolved swamp muck in a solution of about the consistency of porridge, two quarts of this to ten gallons of water, with instructions that the spawn taker place in this such quantity of eggs as the keg would reasonably hold, three gallons being our rule. Mr. Dukes followed instructions, as far as practicable, and brought in one gallon of eggs in starch and two gallons in muck. He reported that if the starch was left ten or fifteen minutes without stirring it settled into a hard cake on the top of the egg mass, incorporating the upper layers, and that it was more work to keep the eggs free with the starch than under our former plan of constant stirring until the adhesive tendency disappears, as in the one case the eggs need attention only while being freed, while in the other they must be almost constantly stirred until the station is reached.

He reported that the muck entirely prevented adhesion and gave no trouble whatever.

After arriving at the station both lots were examined and then placed under running water as usual. The motion of the current carried over nearly all of the starch and a considerable portion of the muck. The next day,

about twenty-four hours after being taken, these two lots were separately removed from the kegs, passed through a screen with meshes just large enough to easily admit of the passage of a single egg, the same as all our eggs are treated, when it was found that there were practically no lumps in either case. In the muck lot there was one lump of five eggs and two of three each, while in the starch lot there was still less, two or three of three eggs each. They were then both put into a screen box with mesh fine enough to just hold the eggs, and all muck was washed out, there being practically no starch remaining.

Examination was then made of both lots with the microscope, which showed minute particles of muck and starch, respectively, adhering thickly all over the outer membrane of the eggs, thus preventing, as Prof. Reighard has shown, the eggs from coming into immediate contact with each other, and thus preventing adhesion. Both lots were worked entirely separate, not being doubled up with others, and showed as near as could be judged by guage measurements a nearly equal percentage of good eggs, about 9½ per cent. above the average of the house, the muck eggs being the best.

On April 16th Henry Curtis, John Dukes and Fred Miller were each furnished with starch and muck and fully instructed in the use of each. The muck was cut down to one quart to the keg, which prevented adhesion. All these spawn takers reported that it required almost constant work to keep the starch from settling into a hard mass, and that it required more work than the old way, while the muck gave no trouble at all, the eggs and muck being simply agitated gently just before introducing a new lot of eggs.

Mr. Curtis finding that the starch settled into a mass unless frequently stirred, worked a considerable portion of it out of the keg. These eggs turned out very fine. Oscar Betts took three jars, about ten quarts, on the 17th, with starch and reported much trouble, but the

eggs were fine. This closed the taking of eggs in starch solution. Eleven jars were taken in all. Thirty-two were taken in the muck solution.

A slight accident in doubling up sample jars treated in the old way prevent exact records of the percentage hatched from eggs taken the same day by the three processes, but a comparison of those taken in muck and starch, and all the other eggs in the house, showed an advantage for the two former of from 7 to 8 per cent., the measurements being taken with the eggs in the jars by guage, the muck treated eggs, as a whole, being the best.

An experiment made after the egg collecting season had closed showed that the addition of about ten per cent. of muck to the starch entirely prevented the starch from settling in a hard mass.

The muck was prepared by taking black muck from the shores of a pond near by, thoroughly mixing to a very thin solution with water, letting the vessel set about half a minute to settle out the coarser and heavier particles, then decanting off the water holding the fine particles in solution, which was left to settle, when the nearly clear water was poured off, the muck being then rubbed through a fine wire screen, when it was ready for use.

The process is very simple, and the muck ready for use easily produced in large quantities.

Whatever credit is due in the success of these experiments much of it belongs to Professor Reighard, whose able papers, published by The Michigan Fish Commission and profusely illustrated in their annual reports, have been of great service to us in the handling of the eggs of the pike perch. Through them, and assisted by the microscope, I have been able to instruct our spawn takers and impress thoroughly on their minds the great importance of using continual care in the taking, impregnating and handling of all kinds of eggs This work is bearing good fruit as will be seen in the percentage of pike perch eggs hatched this season.

FISH CULTURE AND FISH PROTECTION.

THE CHINOOK SALMON.

(Oncorhynchus chouica ; Salmo quinnat.)

ITS NON-FEEDING HABITS IN FRESH WATERS.

BY LIVINGSTON STONE.

It is an admirable provision of nature that the great armies of anadromous fish that annually ascend fresh-water streams to spawn, where there is, practically speaking, no food for them, should be so constituted that they are not obliged, in order to sustain life, to feed in fresh water. Mammals are said to be more ravenous than ever at corresponding periods ; but in the case of anadromous fishes, and possibly of almost all fishes at the spawning season that congregate in large numbers over limited areas, a wonderful exception is made in their favor, in consequence of which they are not only not obliged, in order to support life, to feed where there is no food, but, in the case of Chinook salmon (*Oncorhynchus chouica*), their alimentary organs are so modified at the spawning season that they could not eat if they would ; and in consequence of this again they probably do not suffer from hunger, for if the ability to eat be removed, by natural causes, we expect nature to remove also the desire to eat. One can hardly help wishing that industrial armies had also been included in this exception at all seasons of the year.

That such a provision of nature in the case of fishes is necessary—is absolutely indispensable, indeed—is obvious. The often-repeated story of salmon so thick

in fresh-water streams that one could cross the stream on their backs if he could keep his balance, is true. The writer has seen salmon like that scores of times. It happens indeed every year in all good salmon streams where the primeval abundance of the fish has not been reduced by human agency. Now, imagine all these streams filled, as they are every spawning season, for weeks and months, with thousands, yes, hundreds of thousands of salmon, all crowded together where there is no food for them, and suppose at the same time that it was necessary to their existence to have food. What would be the result? The result would inevitably be that they would soon be driven wild with hunger, and would doubtless in their desperate extremity endeavor, if possible, to return to the ocean. Later on, if they continued to stay in fresh water, they would die of starvation, before the days of their spawning were accomplished, and ultimately the race would in consequence become extinct.

It is evident therefore that the salmon must be enabled to live without food in their fresh-water spawning streams. Otherwise it would be simply suicidal for them to go up the streams to spawn. In other words, if the salmon must of necessity go where there is no food, they must also of necessity be provided with the power of living without food.

The common objection to the statement that salmon do not feed in fresh water, is one that comes up at once in every mind instinctively, namely, that it is not natural for an active creature like a salmon to go without food for so long a period as the salmon have to. The argument, put concisely, is that it is unnatural that they should live so long as they do in fresh water without feeding, and consequently it cannot be that they do not feed there. The reply is that it is much more unnatural that, being compelled to feed in order to sustain life, the salmon should be sent into places to stay for months where there is no food to be had. This would be un-

natural indeed. On the other hand is it not the most natural thing in the world, since the salmon must of necessity be sent up into rivers where there is no food for them, that they should be so constituted that they should neither be starved to death nor tortured by hunger for want of food? Let us look now at some facts bearing upon the question. Some years ago, a large salmon hatching station was built on the Clackamas River in Oregon, and each year a rack was constructed across the river to prevent the ascending salmon from going up the river beyond the station.

In the year 1888 the rack was put across the river in March, and during the summer of that year there were, it is safe to say, upward of 5,000 full grown salmon (*Oncorhynchus chouica*) in sight below the rack. The salmon did not begin to spawn till the middle of September. The great body of these fish were there three months, many of them four months, and some of them five months. During all that summer there was not a moment, night or day, when there were not hundreds of these fish struggling to get past or through the obstruction in front of them, and in all that time there was not visible food enough where they were in the river to provide them with an ounce of food a-piece once a week. In one place the salmon were so thick that a person standing on the rack could with an ordinary carriage whip reach 500 full grown salmon averaging 20 lbs. a-piece in weight, and all of them actively struggling all the time to hold their places against the current. No food whatever was there. No appreciable amount of food could have come down through the rack to them. No food could they possibly have had except such microscopic nutriment as may have existed in the water, and there must have been only infinitesimally small rations of this, when divided up among so many thousand pounds of fish. The only conclusion left is that they must have lived several months practically without eating. There is no question whatever about these facts.

The writer saw the salmon below the Clackamas rack almost every day during the summer of '88. Hundreds of ether people saw them, too. The same thing has happened every year except that there are not so many fish now and they are not stopped so early in the year. The same thing happens every year at the McCloud River in California, where the U. S. Fish Commission has its salmon breeding station, named after Prof. Baird, which the writer has had charge of and where he has watched the salmon for nearly twenty seasons. The salmon do not feed in these streams, or if they do their food is invisible. The same thing happens every year in Rogue River, Oregon, where Mr. R. D. Hume has had for over fifteen years a salmon hatchery on a large scale. Mr. Hume says in his little pamphlet ("Salmon of the Pacific Coast," p. 25) that "it has been the custom at his hatching pond to hold salmon nearly four months, even after they had been held in the river for some time prior to being placed in the pond, and this without supplying them with any sort of food." Many more instances might be furnished of salmon living a long time in fresh water without eating, but those just given would seem to be sufficient. It may be mentioned, however, as incidentally confirming this truth, that although hundreds of salmon have been found with absolutely nothing in their stomachs, not a single instance has ever come to light, at least to the writer's knowledge, of a genuine Chinook salmon being caught any considerable distance above tide water with a full stomach. Futhermore, although thousands of salmon have been known to live several months without eating, not a single case has ever been produced to show that a salmon has not been able to live in fresh water without eating.

It does seem impossble that any creature above the grade of reptiles could live so long and keep so active without eating. It does seem impossible, and hence people argue that "being impossible, it cannot be true,"

but it is a well-known principle of logic that an *a priori* argument like that has no weight whatever against the argument of one unanswerable fact. No *a priori* argument based on the general principle that animals cannot live for months without eating can hold for a moment against actual well-authenticated facts that prove that salmon have so lived without eating, and the Clackamas, McCloud and Rogue River hatcheries furnish these facts without limit and with overwhelming conclusiveness. It is not claimed that the salmon thrive and get fat on this way of living. On the contrary, they get very weak and finally very much emaciated in fresh water. From the moment they pass above tide water they begin to fall off in weight, appearance and general condition, and they never under any circumstances whatever improve their condition afterward. They go on getting weaker and thinner. Every day their blood grows less red and less abundant, until at last their great store of strong red blood that they brought from the sea almost entirely disappears. Every day the rich layers of fat between their flakes of flesh become less noticeable till they disappear also. The dark rich pink of the flesh itself changes to a dirty white. Even their scales are absorbed into the body. Everything about their appearance indicates that a tremenduous draft is being made upon their physical organization. It is without doubt the draft that nature is making upon their flesh to keep their vital organs in the activity necessary to sustain life, and to develope the growing seed that will replenish the next generation. For here, let me also say, it is not claimed because salmon live without eating, that there is nothing whatever to keep their vital forces in action. This would indeed be incredible. This would be having a fire without fuel, an effect without a cause. It would be quite as absurd as the perpetual motion theory—indeed, it would be, in a sense, a realization of perpetual motion. The fire must have fuel, the vital processes going on within the fish must

be sustained by some supply of nutriment—this must be admitted, but this supply does not come from outside the fish in the form of food. It comes from within the fish. It is the blood, the fat, the superfluous flesh that the salmon brings from the ocean in his own body that he lives on in fresh water, and that enables him to sustain life so long without taking food from outside into his stomach, and this explains—indeed it must explain—why salmon do not have to feed in fresh water.

It was remaked near the beginning of this paper that "the alimentary organs of the salmon are so modified at the spawning season that they could not eat if they would." This is easily verified. If any one will examine the viscera of a Chinook salmon, caught well above tide and near the spawning season, he will find that the stomach and throat of the fish are singularly contracted, so much so indeed that one cannot push one's finger down the throat without lacerating the tissues, while the stomach is so shrunken that it will not hold a walnut. If it is very near the spawning season he will find the stomach still more contracted and always absolutely empty, with the exception of about half a teaspoonful of a yellowish, bilious-looking fluid.

Having noticed the good natured controversy going on in the sporting papers about salmon not eating in fresh water, I began last fall to examine some of those that were caught at this station (Baird, Cal.), with especial reference to this question, intending at first to try 100 fish. We did, however, examine the stomachs of only 66 and then we stopped, because they were all exactly alike, and I was convinced that if we had tried 100 or 100,000 they would all have been the same. In every one of them the throats were very much contracted, the stomachs very much shrunken, and all entirely empty with the exception of the yellowish looking fluid just mentioned. As to the throat and stomach, every fish was an exact counterpart of all the rest.

Here we have another admirable natural adaptation

to circumstances. Since the salmon are sent into places where there is no food for them to eat, nature kindly takes away their ability to eat and also their desire to eat. If it were not for this wonderful adaptation of nature it seems probable that the salmon, retaining their appetites, would become frantic with the ravenings of hunger, and abandoning the mission on which they were sent would, regardless of everything else, race back to the ocean to satisfy their hunger on the well-filled stores of food that they undoubtedly well remember leaving. Then, alas for their posterity. There would never be any

The most grateful minded man that I ever heard of was one who, after he had lost every earthly possession, even his last crust of bread, thanked the Lord that he had not lost his appetite. It seems to me a subject both to ourselves and to the salmon of sincere gratitude that the fish *do* lose their appetites when they start on their mission through foodless streams to reproduce their species.

It looks now as if it were pretty well settled that salmon do not feed in fresh water, but when the inquisitors thought they had it all settled about the revolution of the earth by making Galileo retract his statement that the earth moved, the famous astronomer as he was being led away, was heard to murmur under his breath, "It *does* move," and now that it seems to be all settled so nicely about salmon not feeding in fresh water, I imagine I hear more than one veteran salmon hanger say, "They *do* feed in fresh water." I admit it. I would be the last one to deny it, for not only do I know of enough instances of salmon being caught in fresh water with food in their stomachs, to make it folly to deny it, but I have seen the food in their stomachs myself. Last July in particular (July, 1893), I examined the stomach of a salmon caught in the McCloud River about six weeks before spawning season, which had in it four salmon eggs, and the newly

pulverized remains of several insects and larvæ. The salmon eggs came, of course, from the hook that caught it, but the insects it had doubtless picked up from the water in its usual manner of feeding. I must admit therefore that it is undeniable that food is taken by salmon in fresh water. It will be found on examination, however, in every instance where anything is discovered in the stomach of a salmon caught much above tide water, that the food is in very small quantities and composed of very small objects, such as would easily slip down a very small throat and enter a very small stomach, and satisfy only a very small appetite—not enough by any means to disprove the fact that the salmon might, if necessary, have lived without it, but enough nevertheless to prove the fact that salmon do actually feed in fresh water.

The truth is that the evidence compels us to admit both of these apparently conflicting facts, namely, that salmon can and do live for months in fresh water without food, and that they can and do feed during some of the time that they are in fresh water. These two facts are not necessarily conflicting, however, though they may seem so at first. The writer's own theory is that as soon as the salmon, coming from the sea, strike fresh water, their appetite begins to weaken, their throats begin to narrow, and their stomachs begin to shrink. This does not at first, however, entirely prevent them from feeding, but it changes them enough to enable them to overcome the temptation to return to their well-stocked feeding grounds in the salt ocean, and the longer they remain in fresh water the greater the changes become, and the temptation to turn back for food correspondingly less. There is probably no one specified time when an abrupt change comes which deprives them in an instant of their ability and their desire to feed, but in the writer's opinion, the transformation comes on gradually, increasing constantly day by day

from the time that they leave tide water till at the near approach of the spawning season their throats and stomachs become entirely incapacitated for receiving food, and the desire and ability to feed leave them entirely, but, notwithstanding their scanty supply at first and their entire abstinence afterward, the great reserve of superfluous flesh and blood which they bring with them in their own bodies from the bountiful ocean, enables them with little or no food in their stomachs to keep their vital organs in vigorous activity until their momentuous mission up the fresh water streams is accomplished.

Allow me in conclusion to make the precautionary statement that where the word salmon is used in this paper, the word is intended to refer to only one variety of salmon, namely *Oncorhynchus chouica*, commonly known as the Chinook salmon, Columbia River salmon and Quinnat salmon.

RELATIONS OF THE COMMUNITY TO THE FISHERIES.

(A paper read before the American Fisheries Society, 1894.)

As preliminary to the discussion of this topic, it is well to bring to the attention of this Society the extent and importance of our fishing industries. The United States Commission has recently completed and is now publishing a paper on the "STATISTICS OF THE FISHERIES OF THE UNITED STATES." By reference to this report you will find that the commercial fisheries of this country give employment to 182,407 persons; represents an investment in vessels, boats, fishing gear, buildings, wharves and other property, of $58,355,000, and yield products of the annual value of $45,000,000 in first hands. The cost to the consumer is probably three times the amount received by the fishermen, or about $130,000,000 per annum. If we add to the number of persons actually employed in the fisheries those who are dependent upon them, as also the large number of people engaged in various other occupations which are directly or indirectly dependent upon the fisheries, it is safe to assume that the fishing industries of the United States furnish the means of support to over 1,000,000 of the inhabitants of this country, or to one person in every sixty-five of population.

The conditions under which our sea coast and great lake fisheries are prosecuted are peculiar, and without parallel when we compare them with the industries of the land. Individual ownership and control is the foundation upon which rests all of our industrial enter

prises other than those pertaining to the fisheries. The laws give full protection, and every one is free to enjoy the fruits of his enterprise and labor. The farmer plants in the full assurance that he and not another will reap the harvest. He improves his land and increases his investments, knowing that the greater usufruct determined by the exercise of intelligence and energy will inure to his own benefit. What is true of agriculture is alike true of the various industrial enterprises, manufacturing, mining, and commercial, which engage our people. We may safely trust their administration to the intelligence and enterprise of those engaged in them.

In respect to our great commercial fisheries, the conditions are entirely different. Individual ownership of the open waters is not practicable, even if it were desirable; nor can we safely trust to the individual to establish or conserve conditions which are necessary to maintain supply. Indeed it is not reasonable to expect that he will undertake to sow the seeds of a harvest which other men may gather. Intent on gain, he will fail to recognize or appreciate any deterioration of the fisheries, so long as his operations yield him a fair return for labor and investment.

The ownership of the waters is in the State, and they should be farmed for the general use and benefit.

The right of fishing of the individual is subject to the paramount right of the State to prescribe the conditions under which such right may be exercised.

Equal privileges under the law and no invidious discriminations or unnecessary restraints upon the enterprises of the fishermen should characterize the policy of the State in enacting and enforcing such regulations as may be found necessary for the conservation of the fisheries.

The right of the community, through its representatives, to regulate the fisheries and to prescribe the conditions under which individuals may exercise the right

or privilege of fishing being conceded, we must be prepared to admit that the power of the State should be exercised with the most careful conservatism and consideration of the immediate interests to be affected.

The community is concerned only as to the abundance, quality and price of the products drawn from the waters. It is indifferent as to the methods, except in so far as they affect the quantity or condition of the fish supply. When conditions are impaired; when there is evidently a decrease in the fish food supply, then it is incumbent upon the State to adopt measures to arrest the decline. This policy is in the interest not of the community only but also of those who are engaged in the fisheries, or who are occupied with enterprises and industries which are related to them, since the security and profit of investments depend upon the assiduity with which we guard the fisheries from the operation of causes which may determine permanent deterioration. The necessity of intervention to this end being satisfactorily established, we may attempt the regeneration by artificial propagation on a sufficiently extensive scale to repair the waste by natural casualities and man's operations, or we may so regulate the times, methods and apparatus of the fisheries as to permit natural reproduction under the most favorable conditions, or we may resort to both means, artificial propagation being pushed as far as practicable in order to ease or release the restraints upon the operations of the fishermen.

Undoubtedly the rational method of dealing with the fisheries is to supplement, as far as possible by artificial propagation, any deficiency in natural reproduction arising through the operations of the fisheries. Where this can be shown to be adequate, there should be no further interference with the fisheries by legal restrictions or prohibitions than is necessary to insure equal privileges under the law in the exercise of the common right of fishing, or to prohibit or restrict the use of

methods or apparatus that experience has shown to be unnecessarily wasteful or destructive. Whether we can rely entirely upon artificial propagation to compensate for the destruction effected through the agency of man, I am strongly inclined to doubt. The value of this resource as a sufficient means of maintaining production and at the same time imposing little or no restraint upon the fishing enterprises is very forcibly illustrated by the history of the shad fisheries of the Atlantic coast rivers since 1880. This is a species which must find access to the fresh waters of the rivers in order to accomplish reproduction. Where the streams are unobstructed it pushes its way up hundreds of miles from tidewater in order to find suitable spawning grounds. It does not spawn in the brackish or salt waters, and if it did the eggs would prove infertile. Under the present conditions of the shad fisheries, but a very small proportion of the shad approaching our rivers under the constraint of reproduction ever find their way to their spawning grounds in the rivers. Fully eighty per cent. are taken in the brackish water of the estuaries of our rivers or on the shores of the ocean or the great bays which indent the shore line. Under these conditions, we are compelled to depend largely, if not entirely upon artificial propagation to repair the annual waste by natural casualities and the fisheries. This great fishery is under conditions as artificial as is the corn or the wheat crop. Its permanence and such marked improvement as has taken place since 1880 in the annual value of the product is unquestionably to be attributed to the extensive measures of artificial propagation which have been conducted with this species by the Fish Commissions of the different States on the Atlantic Sea Board and by the United States Fish Commission.

Since 1885 there has been a steady and progressive increase in the annual value of the shad taken on the

Atlantic Sea Board, and at present the amount and value of the annual product is nearly double what it was in 1880.

It might appear that the development of the shad fishery as disclosed by the statistics of production from 1880 to 1892, inclusive, would indicate that artificial propagation may be relied upon as adequate to maintain production, even under the most adverse conditions. We must consider, however, that the ability to maintain supply by this means can only continue so long as a sufficient number of shad are permitted to pass into the rivers to furnish the basis of a supply of eggs necessary to carry on the work I cannot disguise the fact that every year we have more reason to apprehend that the existing fishing conducted in the brackish and salt waters will eventually so reduce the number running into the rivers that we will no longer be able to rely upon artificial propagation, unless aided by protective regulations and legal restraints upon the pound net fishing, not only in the rivers but also in the bays.

When we turn to the important salmon fisheries of the Columbia River, we find the same conditions not only impending but accomplished. Comparing the average catch for the five years beginning with 1889 with the previous five years, we find that there has been an average reduction of 150,000 cases in the take of salmon, and a reduced annual value of not less than three quarters of a million of dollars. This is undoubtedly to be attributed to the fact that the appliances for the capture of salmon in the lower river are so numerous, so complete, and so fully occupy every channel of approach that at present very few salmon are able to reach their spawning grounds in the upper rivers. Now what is impending or accomplished in the present conditions of the shad and salmon fisheries certainly will occur in regard to every species the spawning grounds of which are in the rivers. For it is evident, in regard

to any of them, the methods of fishing may be such as in a large measure to shut them off from their spawning grounds. Under such a state of things artificial propagation on adequate scale could be no longer carried on for the reason that we would have no ripe fish from which to draw supplies of eggs.

Now, what is true in regard to our river species is alike true in regard to all the coast species whenever the operations of the fisheries are such as to intercept in considerable measure the movement of mature fish to their spawning grounds. The necessity of the regulation of the fisheries by law is apparent in every case where a knowledge of the habits and movements of the fishes of our coastal waters is such as to indicate that existing methods do seriously interrupt or interfere with their approach to their spawning grounds. What shall be the character of the protective regulations required in the interest of the fisheries must be based upon a complete knowledge of the life history of the species. In regard to many of our coastal species, we are approaching a time when it will be possible to give conclusive information upon this subject which may serve as a basis for such regulations as the conditions of the fisheries may require.

You are all aware that the sentiment as to the necessity of protective regulations in reference to the coast fisheries is now active and aggressive. When the allegation is made that there is a material decline in the products of our fisheries, the fishermen who fear the results of hasty legislation based upon inconclusive data reasonably ask for the evidence as to the decline in the coast fisheries which warrants the attempt to interfere by law with interests which employ a large number of men, a large investment of capital, and which yield products which are very important to the community.

In considering the statistics of our fisheries we may consider the fisheries as a whole and by a comparison

of the census taken at intervals of a term of years, determine conclusively the facts as to aggregate increase or decrease in the period considered. Again, we may make the comparison by geographical divisions, seeking in this way to arrive at local fluctuations which are not indicated in the general aggregate ; and again we may take up the special fisheries for certain important economic species, and by comparison of products determine the fact of increase or decrease in regard to this particular fishery.

I hold in my hand a table giving the comparative summary of the fisheries of the entire United States for the years 1880 and 1892.

	Persons Employed		Capital Invested		Value of products	
	1880.	1892.*	1880.	1892.	1880.	1892.
New England States.	37,043	37,025	$19,937,607	$19,859,508	$12,509,071	$12,445,569
Middle Atlantic States	59,853	90,685	12,685,341	19,405,151	16,360,517	19,047,580
South Atlantic States	7.546	16,138	695,160	1,693,076	1,256,578	1,589,894
Gulf States.....	5,131	12,019	545,584	2,993,080	1,227,544	2,499,495
Pacific States.....	16,803	16,771	2,748,383	8,873,813	5,545.588	7,258,925
Great Lakes Region..	5,050	9,738	1,345,975	5,478,080	1,784,050	2,471,355
Grand total	131,426	182,376	37,958,040	58,302,7 8	38,683,348	45,312,818

This table is taken from a report on the statistics of the fisheries of the United States, prepared in the division of Fisheries of the United States Fish Commission, and based upon field investigations conducted by the employees of the Commission in part under the direction of Mr. J. W. Collins when Assistant in charge of the Division of Fisheries of the Commission, and in part by his successor, Mr. H. M. Smith, now in charge of that work The data are taken in large part from the books of the fishermen. They have been collated with care and judgment, and may be relied upon to

*This year is placed at the head of the columns because it is the most recent one to which the statistics relate, and the one to which most of the figures apply. The data for the New England, Middle Atlantic and Pacific States are for that year, those for the South Atlantic States are for 1891, and those for the Gulf region and Great Lakes are for 1890.

furnish as accurate a statistical presentation of the conditions of the fisheries as can be obtained with the means and resources at the command of the Fish Commission.

By reference to this table you will find that in 1892 the number of persons employed in all branches of the fisheries and related industries in all parts of the United States has increased 38.77 per cent. as compared with the number employed in 1888. The capital invested has increased 53.43 per cent. whilst the total value of the products of the fisheries has increased but 17.14 per cent. This indicates in a general way that the fisheries in 1892, taken as a whole, have not been so productive in proportion to the number of persons employed and capital invested as they were in 1880 We are, however, liable to err if we attempt to apply this general conclusion to the case of any particular fishery, though the general fact is broadly emphasized that our fisheries do not now yield the profitable return to individuals and to investments that they did in 1880.

Referring to this same table and considering the statistics of the fisheries by geographical divisions, we find that the fisheries of the New England States as a whole are practically unchanged since 1880. The number of persons employed is slightly less: the capital invested has been reduced less than one half of one per cent. while the value of the products has increased one half of one per cent.

For the Middle Atlantic States we find the number of persons employed has increased 51 per cent.; the capital invested 53 per cent.; while the increased value of the products is only $16\frac{1}{2}$ per cent. For the South Atlantic States the number of persons employed has more than doubled, being 113 per cent.; the capital invested has increased 14 per cent.; while the value of the products rises to a little above 26 per cent.

In the Gulf States. the percentage of increase in persons employed is 137.95; the capital invested, 82; and the increased value of the products, 103.

In the Pacific States the number of persons employed is about the same as in 1880; the investment of capital has more than doubled, while the aggregate increase in value of products amounts to 30 per cent.

In the Great Lake States the percentage of increase in persons employed is 92.63; of capital invested 232.7; the increased value of the products rising only to 38.52 per cent.

The figures for the Great Lakes are very significant. With nearly double the number of persons employed in the fisheries, and with upward of 50 per cent. increase in the capital invested, there is but 17 per cent. increase in the total value of the product. This comparison is more significant when we consider that the increased production has been brought about by the utilization for market supply of species of fish such as the herring and others which constitute but an insignificant portion of the total products of 1880. The most important fishery of 1880—that of the whitefish—has vastly deteriorated, the take in 1892 being considerably less than one half of the catch of 1880. And this result has arrived in spite of the fact that artificial propagation of the whitefish has been carried on on a stupenduous scale by the different State Commissions and by the United States Commission on all of the great lakes. This deterioration in the number of whitefish is clearly to be attributed to the methods employed, and the necessity of some restraint upon these methods is imperatively indicated, not only in the general interest of the consumer but in the interest of the fisheries themselves.

I would now call your attention to a table of the comparative statistics of the catch of certain species of fish in 1880 and 1892, taken from the same report:

COMPARATIVE STATISTICS OF THE CATCH OF CERTAIN PRODUCTS IN 1880 AND 1892.

	1880.		1892.		Increase or decrease.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	45,684,333	$526,546	59,176,183	$554,740	+13,491,850	+ $28,194
Bluefish	14,707,708	366,756	15,957,836	637,305	+ 1,250,128	+ 270,549
Cod	119,137,350	3,475,106	92,643,811	2,996,691	−26,493,539	− 478,415
Lobsters	20,238,683	631,769	23,301,149	1,050,677	+ 3,062,466	+ 418,908
Mackerel	73,317,563	1,8 3,910	17,041,736	1,102,651	- 56,275,827	− 761,259
Mullet	6,701,950	225,009	21,214,840	387,916	+14,512,890	+ 162,907
Salmon	51,633,824	1,086,339	93,826,527	3,730,416	+42,192,703	+ 2,644,077
Sea Bass	2,642,650	113,176	8,401,553	355,602	+ 5,758,903	+ 242,426
Spanish Mackerel	1,887,423	131,639	1,773,081	129,259	− 114,342	− 2,380
Squeteague	15,463,560	437,022	22,340.433	708,830	+ 6,876,873	+ 271,808

In this table we have arranged by sections the statistics of a number of economic species which furnish the basis of important fisheries. We will take first the alewives or river herring, instituting always comparisons between 1880 and 1892. We find for this species an increased product of 59,000,000 pounds. And referring the increase and decrease to the different geographical sections in which this fishery is prosecuted, we find the increase wholly in the Middle and South Atlantic States, the New England product having fallen off about two and a half million pound. It would appear, therefore, that so far as this fishery is concerned the methods of fishing have had no influence upon the product, and that therefore no restrictions are necessary in regard to this species. As a matter of fact the capture of the herring is made largely in pound nets and in seines. When the fish are taken in the pounds many of them, both males and females, are ripe, and crowded together as they are, involuntary reproduction is accomplished, since the squeezing and crowding of the multitude in the net accomplish precisely the same process that we do in artificial propagation. The eggs under these conditions are fertilized in vast numbers—being adhesive and floating off with the tide, they attach themselves not only to the walls of the net but to every available

object in the tide way—and for this reason I am inclined to think that so far as the alewives are concerned the pound net fishing instead of working any disadvantage is actually improving the condition of this fishery all the time

The next species in order is the bluefish. The census of 1880 gives the total catch of this species for the entire coast at 14,707,000 pounds. The catch of 1892 reaches nearly 16,000,000, being 1,250,000 pounds in excess of the catch of 1880. Considerigg the data by geographical sections we find that the decrease in this species in the New England States since 1880 has amounted to 4,223,000 pounds. The largest increase of 4,321,000 pounds is in the Middle Atlantic States. The increase for the South Atlantic States is 602,000 pounds; for the Gulf States 545,000 pounds, this being a new fishery for that section. Whether the vast decrease in the New England States is to be attributed to the methods employed there or is the result of the larger and growing catch in the Middle and South Atlantic States, is a matter about which we cannot at present form a conclusive opinion.

The cod fishery is prosecuted mainly in the New England and Midddle Atlantic States; there being, however, an important and growing fishery in the North Pacific. Considering the fishery as a whole, we find a falling off of 26,500,000 pounds in product as compared with 1880, the decline being the largest in the New England States.

It is to be noted in connection with this fishery that the species is taken almost entirely, if not entirely, by hook and line, and the greater proportion in offshore waters. The deterioration cannot, therefore, in this case be attributed to any of the different forms of apparatus that are used in our coast waters.

In the case of the lobsters we find an increase of 3,000,000 pounds in the product of 1892 as compared

with 1880, which is to be attributed probably in part to the stringent laws regulating this fishery which are now in operation, and in part to the great increase in the number of persons employed in the fishery.

The mackerel is another important fishery to which I wish to call your attention. We find a decrease in this fishery in 1892 as compared with 1880 of 56,275,000 pounds. The great fluctuations in this fishery from year to year are inexplicable at the present time. In the absence of specific knowledge as to the spawning grounds of the mackerel and the conditions under which spawning takes place, we are not prepared to attribute any influence to methods as now pursued in affecting the results of the fisheries.

The mullet fishery, which is more important in the South Atlantic and Gulf States, shows an increase of 14,000,000 pounds in 1892 as compared with 1880. This increase, however, has no significance as bearing upon the question of regulation, from the fact that it has arisen by the development of new grounds in the South Atlantic and Gulf States, and by more active fishing in the Middle Atlantic States.

The salmon, you know, is one of the most important economic species of the West coast. We find in this case an increased production in 1892 of 3,730,000 pounds as compared with 1880. This certainly furnishes no argument in favor of unrestrained fishing so far as it relates to this species. The increase is due entirely to the development of new grounds, and has been accompanied by an alarming decrease in those rivers which in 1880 furnished a large part of the salmon for market. I refer particularly to the Sacramento and the Columbia Rivers, where there has been marked deterioration in the fisheries, clearly the result of the fishing operations.

The sea bass, or black fish of New Jersey, shows an increased production of 5,758,000 pounds, which is

pretty equally distributed to the three geographical sections of the Atlantic Sea Board. There is no decrease indicated anywhere in either the New England, the Middle or the South Atlantic States.

The Spanish Mackerel is an important economic species, the greater supplies of which during 1880 were drawn from the Chesapeake region. Since that time the fisheries have been extended and largely developed in the South Atlantic and Gulf States. In spite of the productive fishing grounds of the Gulf States, we find a diminished production of 114,000 pounds in 1892 as compared with 1880, the production of the Middle Atlantic States having fallen from 1,852,000 pounds to 976,008 pounds. This fishery, I think, furnishes a marked example of the detrimental influence that unrestrained pound net fishing may exercise upon a coast species. The larger proportion of the catch of Spanish mackerel in the Middle Atlantic States is in the Chesapeake Bay by pound nets on the eastern and western shores The mackerel enter the Bay to spawn; the pound nets are set in the track of the run; the fish taken are nearly all spawning fish; and the disposition of the apparatus of capture is such as to intercept them almost entirely in their approach to waters in which to spawn. In this way the great deterioration in the mackerel fishery of the Chesapeake is clearly to be attributed to the pound net fishing. This species, however, furnishes a clear and well-defined instance of deterioration which we can fairly attribute to the operations of the fishermen.

The last species to which I wish to call your attention is the squeteague. We find for this species an increase of 6,876,000 pounds as compared with 1880; the increase being general for all the geographical sections in which the fisheries are prosecuted.

In considering the question which I have brought to your attention in this paper, it will be interesting to

note the advance of public sentiment in Great Britain as to the necessity of protection to the sea fisheries in territorial waters since the publication of the report of the Trawling Commission of 1863, of which Professor Huxley was president. At that time there was little or no knowledge of the life history or the spawning habits of the different species which were the object of the commercial fisheries. There were no statistics upon which to build satisfactory conclusions. The commission was forced to rely entirely upon the conflicting testimony of those engaged in the fishing interests. In speaking of the perplexities and embarrassments as to the conclusions to be drawn from the conflicting testimony of the fishermen, the Commission states as follows:

"Fishermen as a class are exceedingly unobservant of anything about fish which is not absolutely forced upon them by their daily avocations, and they are consequently not only prone to adopt every belief which seems to tell in their own favor but they are disposed to depreciate a comparison of the present with the past. Nor in certain localities do they lack the additional temptation to make the worst of the present, offered by the hope that strong statements may lead the State to interfere in their favor with dangerous competitors."

The general conclusion of the Commission upon which the advocates of free fishing in this country base their protests against any interference whatever by the state in controlling their operations is as follows:

"1. We advise that all Acts of Parliament which profess to regulate or restrict the modes of fishing pursued in the open sea be repealed; and that unrestricted freedom of fishing be permitted hereafter.

"11. With respect to inshore fishing, although the evidence, so far as it is conclusive, appears to us to prove that the taking of small and immature fish has not yet produced any injurious effect upon the fisheries,

it is undoubtedly possible that, by the use of improved engines, the destruction of fry might reach such a pitch as to bear a large instead of, as at present, an insignificant ratio of the destruction effected by the natural enemies of fish, and by conditions unfavorable to their existence,

"The existence of such a state of things, however, could only be determined by the examination of trust worthy statistics of the fisheries in question, extending over a considerable number of years. Should it ever be satisfactorily proved to have arisen, we conceive that the best remedial measure would be to place a restriction upon the size of the fish permitted to be brought ashore, and subject the possesser of fish below a certain specified size to penalties; but to avoid interfering with the implements of fishermen or with their methods of fishing.

"For the present, we advise that all Acts of Parliament which profess to regulate or restrict the methods of fishing pursued inshore be repealed; with the exceptions, purely on grounds of police, of the local Act regulating pilchard fishing at St. Ives; and, for that part of Loch Fyne which lies above Otter Spit, of the Act prohibiting trawling for herrings in Scotland."

In 1878, fifteen years after the investigation by Prof. Huxley and his associates, a second commission was appointed to inquire into (1) the use of the trawl net and the beam trawl in the English seas, and the territorial waters of England and Wales; (2), into the use of the seine nets and the ground seine on the coast of Cornwall and elsewhere; and (3), into the alleged destruction of fry and spawn of sea fish in estuaries of rivers and bays by the above and other modes of fishing.

This Commission, of which Mr. Frank Buckland was chairman, reached the same general conclusion in regard to the decrease in the supply of fish arising by means of fishing operations as did the previous Commission of

1863. They, however, took strong grounds for establishing legislative restrictions for fixed engines, under which title is included the different pounds, weirs, traps and stake nets, which are in common use on our own shores. The views of the Commission in reference to this matter are of sufficient importance to warrant their quotation in full.

LEGISLATIVE REGULATIONS FOR FIXED ENGINES.

"So far as the fish themselves are concerned, it is not a matter of much importance whether they are taken by a fixed engine or by a movable net. Provided that the use of these engines is not injurious to the fishing, they ought apparently to stand or fall together; and we are inclined, in fact, to arrive at this conclusion with respect to all those engines which are either temporarily fixed to the soil, or which are merely attached, like the stow net, to an anchored boat. But as we have already stated there is another kind of fixed engine, permanently attached to the soil, which seems to us to require much more serious consideration.

"From a fishery point of view there is this difference between a fixed engine and a movable net The fixed engine is always on the spot. It regularly works with every tide, requiring no rest and keeping no Sabbath. The movable net, on the contrary, can only be worked by the active labor of the fisherman. Its use, therefore is intermittent, and its destructiveness limited. It is obvious that an engine that is at work with every tide must, or certainly may, catch more fish than a net whose use is limited to the capacity of the fishermen for endurance. The fixed engine, moreover, covers more ground than the movable engine. The fixed engines in Swansea Bay reach across the greater portion of the Bay. They frequently overlap each other. They do not, therefore, like the movable net, take only a propor-

tion of the fish, but they do, or may, take all the fish passing up into that portion of the Bay.

"The names which fixed engines bear sufficiently indicate their antiquity. 'Weirs', 'garths', 'goryds', 'baulks' 'hangs', 'butts' and 'kettle nets', are corruptions of Saxon, Celtic and Norman words, and have been handed down by successive generations of fishermen from their Saxon, Celtic and Norman ancestors. But, though the engines are certainly old, their use has never been tolerated. Their erection, except on the sea coast, was reprobated in Magna Charta ; they have been prohibited by many succeeding statutes ; and fixed engines may be said to exist not by virtue of the law but in defiance of law.

"There were two reasons which the Legislature constantly gave in the olden time for putting down these engines. In the first place, they interfered with the navigation ; in the next place they gave one fisherman a monopoly of the fishery which was nominally open to all the King's subjects. Fixed engines were, in short, in the first instance, an encroachment on the public rights. Time has in most cases now given their owners a prescriptive right in their use. But the engines were originally an encroachment on the rights of others. The man who erected a fixed engine usually placed it on his own shore. He was usually possessed, therefore, of the soil on which the engine stood. But this is not always the case ; the kettle nets in Rye Bay, and we believe many of the hose nets in Bridgewater Bay, are fixed on the property of the Crown ; and the same thing is probably true of other fixed engines.

"We understand that in Rye Bay and on the Sussex coast, the Board of Trade, acting on the instigation of the Admiralty, have positively refused to allow the erection of any new fixed nets, or to permit the present nets to remain beyond the lifetime of their present possessors. We see no reason why the same rule should

not be applied to all fixed engines, wherever situate, standing on the property of the Crown. It would perhaps be unjust to apply the same rule to fixed engines on private property. Property acquired by prescription has a prescriptive right to exist ; but even in this case we think that there would be no hardship in compelling the proprietor of a fixed engine to state the nature of the engines which he considered he was entitled to use, and to allow him thenceforward only to use such as had been actually worked during some time in the previous ten years."

The conclusion of the Commission in regard to these forms of apparatus is stated as follows :

1. That fixed engines confer a monopoly upon particular fishermen, which is opposed to the ordinary principles of legislation.

2. That those fixed engines which are erected on foreshore, the property of the Crown, should be abolished on the termination of the existing leases or lives on which they are held.

3. That no new fixed engine should be erected on either public or private property.

Passing now to the Trawling Commission of 1885 which pursued the same line of inquiry as the previous Commission already alluded to, we find the following conclusions and recommendations based upon the results of their labors :

SUMMARY OF CONCLUSIONS.

I. In territorial waters from the Moray Firth to Grimsby—
   (a) A falling off of flat fish.
   (b) A decrease of haddock in certain places.

II. In offshore waters.
   No decrease in the total take of fish in the North Sea, except in the case of soles.

III. The beam trawl is not destructive to cod or haddock spawn. There is no proof of injury to the spawn of herrings or other edible fish.

IV. There is no wasteful or unnecessary destruction of immature food fishes by the beam trawl.

V. The number of fish on particular grounds, especially in narrow waters, may be sensibly diminished by the use of the beam trawl.

VI. The injury done by the beam trawl to the food of fish is insignificant.

VII. It has not been proved that the use of the beam trawl is the sole cause of the diminution of fish in territorial waters.

VIII. In the absence of a proper system of fishery statistics and scientific observations, it is impossible to discover the causes or measure the fluctuations of the fisheries.

IX. Much avoidable damage has been done to drift nets and haddock lines, particularly by steam trawlers.

X. Peculiar difficulties attend the recovery by fishermen of compensation under the Sea Fisheries Act, or of civil damages.

RECOMMENDATIONS.

In consequence of these conclusions and of other facts brought before us in the course of our inquiry, we submit the following recommendations to Your Majesty:

I. That a central authority be created to supervise and control the fisheries of Great Britain, if not of the United Kingdom, and that a sum of money be annually granted to such authority for the purpose of conducting scientific experiments and for collecting fishery statistics.

II. That in the meantime powers be given to the Scotch Fishery Board similar to those of the

Irish Board, enabling them to make by-laws for the regulation or suspension of beam trawling, or of any other mode of fishing within territorial waters; and that a sum of money be granted annually by the Treasury for the purposes mentioned in the last paragraph.

III. That a similar authority with similar powers be created for England, and that in the meantime those powers be conferred upon the Secretary of State or President of the Board of Trade.

IV. That statutory powers and means be given to the fishery authorities to enable them to collect adequate statistics.

V. That the cruisers serving under the Scotch Fishery Board, whether employed for police or scientific purposes, be replaced by efficient steam vessels.

VI. That steam trawlers, besides having their number and letters painted on the bow, should also have them painted on the quarter.

Considering this most recent report, it is evident that public sentiment in England, so far as it is expressed in the report of the Trawling Commission of 1885, is far in advance of public sentiment in this country in regard to the same subject.

In conclusion, I desire to say, that in the discussion of this subject, I have aimed to avoid questions or occasions of controversy. I have sought to lay down the fundamental principles upon which it will be necessary to construct such legislation as may be found requisite to remedy actual or prevent impending decrease in our fish supply. No one will dispute the power of the State, having in view the general interest, to prescribe such regulations as may be found expedient. It will be equally conceded that such power should be exercised with the utmost conservatism, and with due

regard to the important interests concerned. It will not be denied, I presume, that the effect of unrestrained fishing in our rivers is to reduce supply, which it is necessary to compensate for, either by artificial propagation or by restrictions in the fishing, or preferably, both combined. This necessity arises from the fact that it is possible in our rivers to intercept or obstruct the fish on their way to their spawning grounds. The further conclusion must be drawn that wherever, in reference to our coast fishes, it can be shown that the methods and locations of the fisheries are such as to obstruct or materially impede access to their spawning grounds, the same results must inevitably happen in reference to these that we have already found to take place in the case of our river species.

The broad fact I wish to impress upon this audience and upon the fishing interests, is this: that the interest of the community is in maintainance of supply, and the interests of the fisheries cannot in any measure be separated from the general interest. Whatever measures are required to increase or maintain production, are as clearly in the interest of the fishermen themselves as in that of the community of which they constitute a part.

M. McDONALD.

Captain Collins said, "Mr. President, I think I can help Colonel McDonald in regard to the statistics he has presented. At the time the investigation was made of the Gulf and South Atlantic States, I was in charge of that department of the United States Fish Commission, and the figures he has given were those of the year 1890. Since that time there has been a system established of getting returns by blanks left with the fishermen, and all the statistics of the Great Lakes were taken in '91, or about that time. I think I am correct in stating that the complete statistics were not taken

for the rest of the Atlantic Coast. I know it has not been covered since 1889. I also know that they have been collected with a great deal of care as relates to certain species for '92 and '93, but I believe that I am correct in saying that these investigations ought to cover all the species. Why I speak of this, is for the reason that Colonel McDonald has said that these papers covered a period of '91 and '92. It is true that these statistics cover some years generally and others specially, and there is no general way that can be taken as a basis for settling this question. It is also true that many of our fisheries fluctuate from year to year and that the statistics for last year will not suffice for this. This I found to be especially the case in Georgia, in the South Atlantic States, as the published reports will show. It will seem that there is a very rapid increase in fishing and also in pound and purse seines, so that if we had complete statistics of the entire interest from Rio Grande to Eastport, Maine, we might have something that would be of value to us. Colonel Marshal McDonald spoke of an increase in the invested capital and the lack of an increase in the products. If he has looked this matter over properly, he will find that a large part of this increase in capitalization is due to the fact that great care is being now taken in the preservation of fish products. Enormous sums of money are spent for refrigerators, and to provide for the preservation of fish when the supply is in excess of the demand. The increase in the capitalization, therefore, can hardly be taken in comparison with the increase of products, as the majority of the increase in money has been spent in these refrigerating houses. I also believe that there is a large increase in the capitalization of the fisheries in the South Atlantic and Gulf States, where a great deal of money has been expended in establishing new fisheries, and also in plants for packing oysters and preserving the products of the

fisheries. All these things should be taken into consideration or else we may be misled in taking general statistics. I have given this matter careful consideration and am satisfied that statistics can be obtained that will be absolutely accurate and will tell the whole truth."

THE FOOD-PROBLEM IN FISHCULTURE.

BY CHAS. G. ATKINS.

Any one reviewing the fishcultural literature of the last few years can but observe that attention has been to a remarkable degree concentrated on subjects pertaining to the nutrition of young fishes. The main question is no longer how shall we obtain the eggs of desirable species, or how shall we impregnate them, or how incubate them, or how many of the fry can we liberate ? but how shall we feed the young fish ?

There appears to be a very general agreement among fishculturists that it is desirable, not to say necessary, that the nutrition of the young fish resulting from artificial operations, should no longer be left to nature and to chance, but should be made the subject of man's most earnest study, and the object of his direct care. The negative of this proposition is hardly maintained by even the most conservative member of the craft. Those who have seemed to array themselves on the negative side, appear to me to be merely maintaining the insufficiency of the methods of feeding which have thus far been brought to their attention.

I may say that for myself, after a careful study of the situation, and of the expressions of other fishculturists, I have reached these three conclusions : first, that the practice of holding the fry of salmon and trout in confinement and feeding them for some months after hatching is a distinct improvement over the practice of liberating them as soon as they can feed : second, that we have a fair prospect of effecting this work with due economy : third, that there is good reason to expect the

best results from feeding with live food. To the latter theme I will devote this paper

In a paper read before this society last year, Mr. Page admonished us that we were allowing European fish-culturists to lead us in this most important branch of the art This is unquestionably the fact, but I think we need not to hang our heads with shame on that account. The present stock of knowledge in this department and the most advanced achievments have been a natural outgrowth from experience in pond-culture, an industry hardly yet known in America, but one that dates back hundreds of years in Europe, and is followed in some districts on a very large scale. In Bohemia and Silesia there are fish-farms with hundreds of acres of water. At Wittingau, in Bohemia, a single fishculturist, Mr. Joseph Susta, has charge of ponds covering 15,000 acres, a considerable portion of which can be periodically drained and flowed. These great fish-farms were in existence and profitably conducted after a well-established routine many generations before the so-called artificial fishculture had its birth. It was, moreover, a live-food method, though hardly known to be such, even by its practitioners. The introduction of artificial propagation of salmonidae and other fishes, and the general dissemination of interest in the scientific study of animal life during the last 53 years has reacted on the fishculturists, and quickened their faculties of observation, and they have recently made some important discoveries.

One of the most important of these discoveries, made by Mr. Susta of Wittingau, relates to the character of the food of fishes, especially the carp. It used to be held as a dogma that the carp fed mainly on vegetable matter. Even as late as 1863, Raphael Molin, the author of a work of some reputation on "The Rational Culture of Freshwater Fishes," gave this account of the food of the carp : "The carp delights in quiet water with

rich muddy bottom, in which he bores with his head in the search for worms, larvae, &c., on which, together with grass, young rushes, other vegetable substances, animal excrements, swollen barley, kitchen refuse, &c., he subsists." Not satisfied with the results of management based on these theories of the habits of the carp, Susta undertook in 1876 a systematic study of the contents of the alimentary canal of the carp. Hundreds of specimens, from many different ponds, under various systems of feeding, were dissected and the results of the inspection carefully noted, with evident faithfulness and candor. As a result he reached the conclusion that the carp in reality subsists on animal food exclusively; and that the vegetable constituents of the contents of the stomach and intestine could only have been swallowed by accident, and in fact were voided by the fish almost wholly unaffected by digestion.

Susta extended his investigations to other species and found only three sorts which could be considered plant-feeders. He classifies the ordinary European pond-fish aside from the carp, on the basis of their food, into (A) fish of prey: (B) eaters of small animals: (C) vegetarian.

In the category of fish of prey, he names the pike, perch, ruff, (a percoid), pikeperch, brook trout, eelpout (*Lota*), sheat fish (*Silurus*), and eels. As eaters of minute animals, he gives us the maraena (*Coregonus*), cruciancarp, tench, gudgeon, and eight other species of cyprinoids His list of vegetarians comprises only three species, namely, the dobule (*Squalius dobula*, Heck), the roach (*Leuciscus rutilus*, Heck), and the rudd (*Scardinius erythrophthalmus*, Bon), all cyprinoids.

More recently Dr. Otto Zacharias, director of the biological station at Plon, has made similar investigations of the stomach contents of numerous species of fish and reached the conclusion that the above three species are the only vegetarians among them; and the researches

of another German investigator, Dr. Dröscher, of Schwerin, indicate that one of these, the roach, is sometimes largely an animal feeder.

It is probable, therefore, that we have no vegetarian feeders among the fishes yet subjected to cultivation in America, or among those that are of sufficient importance to call for cultivation in the future, except possibly as furnishing food for more valuable species. All the salmon and trout and whitefish the grayling and smelts, the perch, the bass, &c., must be regarded as strictly animal feeders.

Mr. Susta's classification is liable to this criticism, that though it may apply correctly to the adult stages of all the fishes mentioned, it does not recognize the fact that when very young, all the predatory fishes must perforce take their food in very small mouthfuls, and are therefore in their early stages to be classed with carp and tench and the coregonoids as subsisting on minute animal life. Now the great problem of fish-feeding with us is, at present, and perhaps will always continue to be, how properly to nourish the fish through their early stages; so, whether we are rearing carp or trout or salmon, the question of providing minute animals for their sustenance is one of paramount interest.

While Susta was studying the digestion of his carp, another fishculturist, Thomas Dubisch, the manager of a large pond-interest in Austrian Silesia, was perfecting and reducing to practice a system of management for carp-ponds, of his invention, which has attracted great attention, and is likely to be generally adopted by carp-breeders; and from which we can sefely draw lessons for our guidance in the culture of salmonidae in ponds.

The Dubisch method, or that portion of it with which we have to do, consists essentially in having a soft and rich bottom to the pond, and drawing off the water so that the pond shall be completely empty and dry as long as possible each year, including the winter. If a

pond is emptied of fish in the autumn it is immediately laid dry and allowed to remain so until just before putting fish into it again the next spring or summer. The purpose of the soft and rich bottom is to encourage the growth of animal life. The laying dry is useful in two ways: first, it destroys predatory insects and other vermin which, in a pond continually filled with water, become so abundant as to prove very destructive to fish-food and to the young fish themselves; second, through the drying and freezing it appears to directly encourage the development of the eggs of the small crustacea which form the most important part of the food of young fish. The water-level must be reduced to at least a foot below the bottom of the pond, else the vermin may not be destroyed.

Here we have reached what may perhaps be considered the most important point in the whole live-food business, the encouragement of the food and the destruction of the vermin by the simple process of laying the pond dry. The life-economy of the small crustacea, the entomostraca, is adapted to just these conditions, water for a portion of the year, drouth and frost for the rest. It can hardly have escaped the attention of any one interested in these matters what multitudes of minute creatures people the pools that are filled with water in the spring and dry up in the summer and autumn. It is nature's way, and in devising his system Dubisch has simply been following nature.

The most important members of this pool fauna are the entomostraca, the daphnids, copepods, ostracods, and their relatives. They owe their importance to their ability to endure drying and freezing as mentioned above and also to the enormous rapidity of their reproduction. A Daphnia, for instance, is endowed with the faculty of producing, under proper environment, such as obtains in the spring, generation after generation of

young without the intervention of the male ; these young are all females and all likewise capable of reproducing without the male. The mother gives birth to living young every three or four days, say an average of 15 to a litter. In a week or ten days these young are mature and begin in their turn to reproduce. Thus in the course of 60 days, according to one calculator, the descendants of a single Daphnia may number more than twelve hundred millions. Such enormous fecundity is not found, I think, among any other creatures that are of suitable size to serve as food for fish. The other entomostraca are also very prolific.

Given plenty of entomostraca, the first condition of growth of young fish is met. But the multiplication and growth of the entomostraca is only possible when they too have an abundance of food, and they also are animal feeders. So another group of animals still more minute must precede the entomostraca. These are found among the protozoa, whose food is decaying vegetable and animal matter, such as is found to a certain extent in ordinary rich earth, and much more abundantly in animal excrement and the debris of succulent plants. Thus the basis of the system is a pond-bottom rich in animal and vegetable matter in process of decay. This nourishes abundance of protozoa ; the protozoa nourish the crustacea ; the crustacea nourish the fishes.

The question naturally suggests itself how far we may expect a system devised for carp and found applicable to their culture to meet the demands of trout and salmon culture. Truly only in a very general way, until experiment determines the details of its application. I am not in possession of any authentic evidence that salmonidae have been reared in ponds managed after the Dubisch or any similar method. Yet there seems no good reason to doubt that it is quite feasible so to grow them. Trout have been grown very suc-

cessfully in ponds on natural food. At the meeting of this society in 1892 [see report, page 64], Mr. N. K. Fairbank of Illinois, described his method of growing trout in an artificial pond fed with spring water, wholly on the food produced therein, without any care further than to put into the pond quantities of a weed on which he had found a good many shrimps, put in the fry and let them alone. In this way he estimates that fifty per cent. of the fry live to be yearlings. This he has done year after year.

In a paper read at the meeting in 1892 Mr. Page gave several instances of parties growing trout successfully on live food. One of the parties referred to was Mr. Thomas Andrews of Guilford, England, who rears trout on a very large scale in ponds supplied with spring water, of a temperature ranging from 49 in winter to 56 in summer, making very considerable use of live food, especially shrimps (*Gammarus*) and snails (*Limnaea*) which are grown in separate ponds and transferred to the fish-ponds to be eaten, and in some cases allowing trout to forage for themselves, without any artificial help, but depending mainly on chopped horse-flesh. From some more recent writings of Mr. Andrews and some other sources, I learn that he has made no attempt to imitate the methods of the continental pond-culturists, has little faith in their theories, and considers *Gammarus* and *Limnaea* superior to *Daphnia* and other entomostraca as food for trout. In some of the water-leads between his ponds, he is able to take at one time, with little trouble, "many solid gallons" of small animals, mainly *Gammarus* and *Limnaea*, yet this abundance of life appears to be an accident of the conditions existing and not a part of the scheme of management.

It is well known that carp are most advantageously bred in shallow ponds in which the water becomes very warm under the influence of the sun, and the difficulty

suggests itself that ponds in which the crustacea can be produced by the Dubisch method may be too warm for the trout or salmon, and that on the other hand if we keep the temperature down to the point required by the health of the fish, it may be impossible to rear their food. Dr. Kochs of Bonn, has advised that this difficulty be avoided by growing the crustacea in shallow ditches connected with the cool pond or brook in which the fish live, and into which the crustacea will be washed by the currents created by the rise and fall of the water. This idea has been elaborated by Mr. Karl Wozelka of Prague, in a little book recently published, entitled "New Methods of Fish-breeding combined with Willow culture," in which he presents several plans, worked out in minute detail, of systems of breeding ditches and basins connected with ponds and with brooks, claimed to be drawn from his own experience. Some such system would probably prove practicable.

It is quite possible that the identical species of crustacea grown in the carp ponds might not thrive in water cool enough for trout, but there are others that surely would. Many copepods are found in early spring in very cool pools, sometimes at Craig Brook even anticipating the disappearance of the ice, and several species of daphnids occur in active condition in the depth of winter. The careful observations on the occurrence of aquatic animal life during each day of the year ending Oct. 31, 1893, at the biological station at the lake of Plön in the northern part of Germany, disclosed the presence, in abundance, of several species of entomostraca during every month of the year. From January to April, inclusive, there was the greatest scarcity, yet no less than seven species of etomostraca were abundant in mid-January, and with the exception of the period from March 20 to April 10, there was no part of the entire year when some species was not found in abundance.

I had some years ago an opportunity to note, at Bucksport, Maine, a phenomenon of like character with those recorded at Plön. In the Fall of 1872 I built a dam across a brook in Bucksport, to obtain a head of water to use in a hatchery. The ground was part of an old pasture, and cows waded freely about in the brook, and for a time, in the small pond formed by the completion of the dam. A portion of the ground flowed was a small alder swamp. Late the following winter there came down into the hatchery great numbers of living entomostraca, mainly Daphnids. We practiced at that time the filtering of the water through a flannel screen set across the head of each trough, and so great was the number of the entomostraca that they often completely clogged up the screens, causing the water to overflow. This continued for several weeks. The pond was all the winter covered with ice, and the mean temperature of the water was as follows : in November, 39.1 F. ; in December, 35.17 ; in January, 34.5. Whether these entomostraca subsisted on their normal food, protozoa, or not, it is evident that they found sufficient nourishment even in that very cold water, and we are warranted in drawing the conclusion that daphnids may not only be bred in water cool enough for salmon and trout, but that they may probably be brought out at any season of the year by proper management.

The elaboration of methods of managing fish-ponds for the production of live food appears to me, therefore, to be the most important task to which fishculturists can in these days address themselves. It may require a great deal of experimentation and study, and perhaps much patient waiting, but I cannot doubt that a satisfactory system of management will finally be evolved, the introduction of which will constitute an advance in fishculture as important as the introduction of artificial impregnation and incubation.

ALASKA'S FOOD FISHES AND THE INTERESTS OF ITS FISHERIES.

BY Dr. BUSHROD W. JAMES, PHILADELPHIA.

MEMBER OF PENNSYLVANIA FISH PROTECTION ASSOCIATION.

Probably I should give as my reason for so often writing upon the natural resources of Alaska, that having visited the country and become a member of its historical society, I consider myself in a measure identified with its admirers and defenders. The seal industry alone has given the Territory importance for so many years, that the recent disturbance, judging only from that standpoint, appears to have demoralized it to such an extent that its future might be considered as almost hopeless, so far as its value to the United States is concerned; but the seals actually represent but a small percentage of its great resources, among which gold, silver and coal have prominent positions. Yet I have no doubt that more extensive investigation will demonstrate that seals, gold, silver and coal are surpassed in value by the immense quantities of excellent food fishes which attain to great size and perfection in the peculiarly pure waters of Alaska.

Dr. Tarleton H. Bean, whose position as a member of the United States Fish Commission has led him to minutely examine into the numerous kinds of food fishes in Alaska, and their approximate value, has returned such an extended and accurate report of his investigation to the government, that I may be considered rather bold in touching upon the subject. As my defense, I will mention that Dr. Bean's report is so identical with

the statistical business of the United States Fish Commission that it has not obtained the wide-spread publication which would have placed it before the great community of readers who are interested in such matters.

Much of my knowledge upon the food fishes I have gained through consulting those reports as well as the various books published by travelers in Alaska. To this I have added by my tour in that country and still more probably by taking a merely common-sense view of the whole subject. We are well aware that fish must always be, as it ever has been, a staple article of diet with islanders and coast dwellers. Year after year its popularity has spread inland, until fine smoked, salted and canned fishes are welcome to nearly every-one's table. The marked improvement in the preparation and preservation of fish has made the demand greater from season to season, and refined tastes have created a desire for the best and most delicately flavored of the various kinds. To supply the greatly augmented requirement, the large Eastern fisheries have in some places been depleted, while in others the stock has deteriorated through too continuous catches. Looking Westward, we can see plainly wonderful quantities of the same kind of fishes ready to replenish the failing stores and to take the place of the Eastern supply, at least until time is allowed for their renewal in growth and numbers. Perhaps we may not obtain the truly fresh fish as it lands in the California markets, imbedded in pure, translucent ice, but cod, halibut, herring and mackerel for drying, salting or smoking, and salmon for canning are more than abundant and proportionately fine in size and quality.

The several kinds of salmon were the subject of the paper offered by me for the consideration of this association two years ago; therefore I need not touch

upon them at this time except in the brief table of statistics which is appended to the present article.

The halibut of Alaska grows to a great size, sometimes weighing three hundred pounds and even more. It is a very important fish to the natives, who devote themselves to its capture almost exclusively. Smoked halibut is very excellent in flavor and must some day win its way into our markets, though as yet only a few thousand cases are prepared for commerce.

Cod of Alaskan waters is almost analogous with the fish of the eastern coast whose fame is wide-spread, except that it grows larger and by dealers in the Western States it is considered superior in both fibre and flavor Another point in its favor is that as far east as Chicago, it is cheaper as well as better than its compeer of the Atlantic. The value of Pacific cod may be roughly estimated by the returns for its receipt in San Francisco in 1893, when there were 1,243,000 fishes delivered to the numerous dealers. Even at variable prices the income must be large, for the fishes sometimes when caught reach a weight of thirty pounds each. The receipts of these fish alone at San Francisco have amounted to 29,123,800 fishes between the years 1865 and 1893.

Even estimating the individual weight to be small the returns seem to prove that the Cod Fisheries alone are well worthy of protection. Cods abound in the sea and ocean around the Aleutian Islands, and are so plentiful that they can be obtained at almost any time in the year. Taking the statement of dealers in Chicago and other central Western cities regarding quality and price it is reasonable to believe that a systematised arrangement could be made which would benefit commerce in the States and aid the islanders in gaining a less variable livelihood; for the poorer part of the population on the islands and near coast are practically compelled to fairly gorge themselves during the season

when seals, whales or walruses can be obtained, and live a life of semi-starvation the remainder of the year.

Alaskan herring is positively so super-abundant during the running season that millions are thrown upon the beach by the tides, where they remain to perish, a most reprehensible practice there or elsewhere. Perhaps the possibilities of this fish cannot be highly estimated because of the lack of fuel to use in smoking, the only manner in which this species seems to be considered palatable. But there may yet be a way found by some enterprising American to utilize this enormous production of the sea. From the great waves which leap far on to the shore in stormy weather, thousands of tons of kelp, a strong, ropy sea-weed, are thrown and left beyond the reach of their recession. The natives use this for fuel but leave vast quantities to waste Perhaps the time will come when this material will be used in preparing the fish for Eastern markets. Used for food when fresh, it is claimed to have superior qualities to those of the herring of the Atlantic coast.

Mackerel, that prime favorite of salted fish, abounds in quantities almost beyond belief. The vast schools appear near the coasts at Attu literally piled one upon another. They grow to fine size, and the flavor is said to be the same as that of Atlantic mackerel. Their season is short—from June 1st. to July 31st—but Mr Lucian Turner asserts that from his own observation "500 barrels of 200 pounds each could easily be prepared at the rate of about $2.00 per barrel." It would be a slight matter to erect fish-curing sheds (men work willingly for a $1.00 and women for 50 or 75 cents per day) and as the Alaskans are experts in cleaning the fish, doubtless Mr. Turner's estimate could be over-reached by systematic labor. The value of these few species of fish alone would pay for investment in the addition to the stock for trade, and go a great distance in teaching the natives to utilize the abundant products

of the sea in obtaining other comforts for themselves through the profits of their work.

The size to which fish attain in Alaska appears almost incredible. White fish of from thirty-five to forty pounds in weight are common in the waters from St. Michael's to Anvik. During the season they are eagerly sought for by the natives. Black fish grow very large and are wonderfully abundant. Dr. Bean and Mr. Turner state that they run for "many miles along the coast, and into the rivers where they are the chief dependence for about three thousand inhabitants with their dogs. In three months sixty-nine tons are taken. The average is about 103.5 tons in a season." These as well as Tom Cod and Lamprey Eels are frozen in grass bags or possibly left upon the ice to be chopped in pieces when wanted. Sometimes the mass is sliced and eaten raw, and often it is boiled, but in either case the natives often have only this form of food, when other food supplies are unattainable. By a grateful adaptability to circumstances neither men nor dogs seem to desire anything better.

The fishes which I have here mentioned are but a few of the most valuable of the many excellent species which are plentiful beyond computation. There are flounders, greylings, smelts, sticklebacks, eels, sturgeon, sculpins, and in fact nearly all kinds of fishes from whales to minnows, and all enormously abundant. By this we can plainly see the peculiar provision which nature has made for both the human and animal inhabitants of that strange north country. The people are poor in every comfort outside of that to be obtained from the creatures of the ocean or its near neighborhood. Confined to a country in which land animal food is but scarcely distributed, and vegetables, fruit and milk are unknown, the human inhabitants have been necessitated to subsist upon that which could be found in sufficient quantity. Salt being an almost unknown commodity

until the advent of the Russians, they have been contented in earlier days to eat from year's end to year's end, unsalted fish, whale, seal and walrus, a diet that would be utterly abhorrent to anyone but themselves. They have found in these mammals all the requirements for food and clothing, fire and light, and in their absence fish and a few roots and berries have been their only luxuries. The love of home is innately strong, so the manner in which to make them more comfortable and nearer to equality with the other inhabitants of the United States is to teach them to utilize for trade all the food fishes possible.

Naturally those who live in the more remote localities will be sometime in their pristine condition and the great duty devolving upon those who are in power is to protect their main stay in the sea and its tributaries. The smaller fishes are the food of the larger, such as cod, halibut, salmon, herring and mackerel; these again are the prey of the still larger, and the very existence of one depends upon the safety of the other. The profits in whale fishing have fallen off considerably because of the manner of slaying and the greed of those who are not careful in selecting their animals. Explosives particularly, not only destroy the monsters who are sought for oil and bone, but they injure the more abundant smaller fishes.

Direct from a San Francisco whaleman comes the news that his vessel made its usual voyage, which occupied nine months, when it was compelled to return for provisions with but one medium sized whale for the season's returns. This individual blamed the disastrous season on the illicit fishing, and the use of fire-arms and powder, which frighten the timid creatures away from their haunts. The loss to the whaler is serious, but the natives who depend upon the cetaceans for their living in certain parts of the year, must suffer pitiably by their absence.

A strangely consistent array of benefits will arise in the proper protection of the seals in the Behring Sea because the interest in that will redound to the good of all. If fishing vessels desist from unseasonable hunting, whales and walruses will most probably return in numbers to their old haunts.

The protection of food fishes will commensurately preserve the food of the greater animals, and smaller fishes will multiply in numbers sufficient to supply food for those of greater value. A law requiring fishes of no marketable value to be returned to the sea immediately, will prevent great loss in the food supply of important mammals and large fishes, and prevent some of the most unpleasant hindrances to those who are unwilling to engage in the business because of the odor of decaying fish. Doubtless, the offal from canneries and salting and drying stations could be utilized for fertilizers with but little trouble.

If the location renders it impossible to reduce the pulp to anything of value, it surely could be returned to the water and become the food of other fishes or crustaceans. The plausibility of civilized and comparitively delicately reared white men engaging in the laborious part of catching and cleaning food fishes for market is very doubtful, but the natives seem willing to work for wages, and if they are taught the mode of preserving to suit the market both East and West, there will be no great need for white men to engage in the manual labor.

Doubtless, Aleuts could be taught to become trusty superintendents as well as workmen, and companies need but employ a few others to oversee, and attend to packing and shipping. There is no possible mistake in asserting that with proper management there is a mine of wealth in the fisheries of Alaska. The Eastern coast has not within the knowledge of history ever been the vast, almost illimitable store-house of food fishes

which Behring Sea, the North Pacific and their numerous tributaries are to day. The United States in general needs this grand supply to add to its commercial value, and the Treasury can make profitable use of the revenue which will result. And a question which is of vital moment is the great good that must accrue to the people of the country. They need to be brought nearer to the standard of the rest of the nation. To bring them into closer touch with the sister states and territories, no plan could be adopted more certain and consistent with all the laws of right than to teach them to use for themselves the best means of utilizing that with which nature has supplied them in super abundant measure.

In order to give an idea of the value of a few of the fisheries of Alaska, I beg leave to append the following statistics whose authority is unquestionable, having been calculated from the accounts of Dr. Tarleton H. Bean, Mr. Lucian Turner, Mr. E. W. Nelson and Mr. Frederick True, and also from the "Alaskan" a bright little paper published at Sitka, the capital of Alaska.

For the year 1893 the returns of salmon at San Francisco were 693,262 cases of canned fish (with one district not reported) and 32,102 barrels of salted fish.

Estimating the value at $4.00 per case it would reach $2,773,048 for the canned salmon. The salted at previous estimate, $9.00 per barrel, would amount to $288,918.

The receipts of Pacific cod in 1893 were 1,243,000 fishes, while the returns from 1865 to 1893 reached the enormous aggregate of 29,123,800 fishes. The value in 1889 was $50.00 per ton, which would make the total valuation for those years at least $205,725.

Summing the value of the salmon for the year 1893 alone, and that of the cod mentioned above, we would have a total from those two only partially devoloped industries of the Territory amounting to the round sum

of $3,267,691, or nearly one half of the purchase money of our northwest possessions.

The total amount of canned salmon in Alaska from 1878 to 1890 was valued at $9,008,497; the salted from 1881 to 1890 yielded $603,548. The full receipt for cod from 1868 to 1890 equalled $1,246,650; and the products from the whales were valued at $11,057,418. Allow me to conjoin the value of these three fisheries alone and we have the grand total of $21,916,113, more than three times the purchase money. This has no connection with the profit from any other industry whatever and tells for itself whether the object of the United States Fish Commission and Fish Protective Associations are not both laudable and necessary adjuncts to the advancement of the great commercial interests of our country as well as to the aggrandisement of its people and the developement of its northwestern resources.

For comparison permit me to add the value of the Furs, mostly

Sealskins, - - -	$48,518,929.
Gold and Silver, - -	4,631,840.
Ivory, from Walruses genl'y	147,047.
	$53,297,816.

being the aggregate from 1868 to 1890.

Thanking my colleagues for their earnest attention and their patience with my rather dry details, I retire with the hope that the Fishing Interests of Alaska have not suffered from my earnest desire for their protection and advancement.

COMPARATIVE SUMMARY OF THE FISHERIES OF THE UNITED STATES IN 1880 AND 1892.

States.	Persons employed.		Capital invested.		Value of products.	
	1880.	1892.*	1880.	1892.	1880.	1892.
New England:						
Maine	11,071	15,128	$ 3,375,994	$ 2,882,113	$ 2,742,571	$ 2,225,806
New Hampshire	414	373	209,465	93,328	176,684	91,481
Massachusetts	20,117	17,025	14,334,450	12,980,679	7,959,760	7,531,194
Rhode Island	2,310	1,584	596,678	1,034,467	696,814	725,675
Connecticut	3,131	2,915	1,421,020	2,868,921	933,242	1,871,413
Total	37,043	37,025	19,937,607	19,859,508	12,509,071	12,445,569
Middle Atlantic:						
New York	6,465	12,246	2,573,535	5,282,970	3,763,537	4,784,753
New Jersey	6,220	10,433	1,492,202	2,517,764	3,103,927	3,625,890
Pennsylvania	452	2,220	94,801	976,011	276,600	284,031
Delaware	1,979	2,247	268,231	218,129	997,695	250,865
Maryland	26,008	39,944	6,342,443	7,465,718	5,221,715	6,460,759
Virginia	18,864	23,595	1,914,119	2,944,559	2,997,043	3,641,282
Total	59,989	90,685	12,685,331	19,405,151	16,360,517	19,047,580
South Atlantic:						
North Corolina	5,274	10,274	506,561	1,243,988	845,695	1,027,669
South Carolina	1,005	2,701	66,275	127,762	212,482	202,602
Georgia	899	1,622	78,770	174,431	119,993	123,563
Florida	368	1,541	43,554	146,895	78,408	236,060
Total	7,546	16,138	695,160	1,693,076	1,256,578	1,589,894
Gulf:						
Florida	2,112	4,335	362,563	1,377,057	564,819	1,103,809
Alabama	635	618	38,200	135,290	119,275	154,871
Mississippi	186	1,721	8,800	434,710	22,540	245,699
Louisiana	1,597	4,068	93,621	719,876	392,610	681,284
Texas	601	1,277	42,400	319,122	128,300	313,832
Total	5,131	12,019	545,584	2,993,080	1,227,544	2,499,495
Pacific.						
California	3,094	5,426	1,139,675	2,526,962	1,860,714	3,044,731
Oregon	4,483	4,200	687,000	2,220,667	605,302	868,406
Washington	3,096	4,296	474,708	1,590,481	417,932	934,940
Alaska	6,130	2,849	447,000	2,535,703	2,661,640	2,410,848
Total	16,803	16,771	2,748,383	8,873,813	5,545,588	7,258,925
Great Lakes:						
New York	922	1,498	59,050	697,847	154,870	256,596
Pennsylvania	114	403	24,700	283,238	43,450	211,122
Ohio	1,046	2,738	473,800	1,874,900	518,420	618,683
Michigan	1,781	3,343	442,065	1,458,884	716,170	934,005
Indiana	52	94	29,360	21,549	32,740	21,693
Illinois	300	386	83,400	420,545	60,100	23,836
Wisconsin	800	1,225	222,840	481,374	253,100	399,272
Minnesota	35	51	10,160	170,743	5,200	6,238
Total	5,050	9,738	1,345,975	5,478,080	1,784,050	2,471,355
Grand total	131,426	182,376	37,958,040	58,245,406	38,683,348	45,312,818

* This year is placed at the head of the columns for the reason that it is the most recent one to which the statistics relate, and the one to which most of the figures apply. The data for the New England, Middle Atlantic and Pacific States are for that year; those for the South Atlantic States, the Gulf region and Great Lakes are for 1890.

IMPROVED METHOD OF HATCHING SMELTS.

BY FRED. MATHER.

Outside of my own articles on smelt hatching in the fourteenth, fifteenth and sixteenth Reports of this Society, I can find nothing on the subject except an item in the paper of the late Prof. H. J. Rice on "Salt as an Agent for the Destruction of the Fish Fungus" in the thirteenth Report. On page 19 Professor Rice records that in 1877 he was studying the embryology of the smelt and found the eggs in masses in the hatching jars and covered with fungus, but not until 1884 did he have a chance to try the effect of salt on killing this *Saprolegnia*. The eggs were upon blades of sedge, or water grass, after the manner employed by Mr. Charles G. Atkins some years before, which "prevents to a great extent, if not entirely, the massing together of the eggs, since the rough surface of the blades allow only a single layer, at most, to adhere to the surface." Still there was much fungus present. The salt killed the fungus and "only about five per cent. of the whole number failed to hatch." This is a much better percentage than I can show to-day, and I do not know of any other fishculturist who has hatched this fish within the past five years. Professor Rice did not do the hatching but merely studied the development of the embryos and took the statements of others regarding the percentage; and the latter need salt, also

In the fourteenth report of this Society, for 1885, pages 17 to 32, will be found my first paper on this subject, with discussions following it by Hon. Theodore Lyman and Prof. Rice. My paper was entitled

"Protecting and Hatching the Smelt," in which I advocated a protective law, which is now being asked for from the supervisors of Long Island towns. Skipping this part of the subject, we will take up that which relates to the hatching of smelts, omitting many details related in that article, and will quote: "Up to the thirteenth day after taking there was little change, and on the twentieth (of March, or seven days later) the eggs were put outside the hatchery in swift water, as they began to show fungus March 26 about one-half were alive, and these were in bunches covered by dead eggs and fungus. All the outside eggs were dead and I had little hope of saving any" That year we allowed the eggs to adhere to grass, sticks and stones, as well as to the sides of glass hatching jars, and in that Report of 1885 I expressed the belief that smelt eggs seemed to require a coating of fungus and decayed eggs about them in order to be protected from too much oxygen and fresh water to hatch well, a statement that I do not believe to-day. We turned out 100,000 fry that year in spite of fungus, rotten eggs and accompanying foul odors in the water.

Again, in the fifteenth Report of our Society, pages 10 to 16, will be found another article of mine, headed "Smelt Hatching," with discussions by Mr. Frank N. Clark, Mr. Bissell, Dr R. O. Sweeny and myself. My paper merely recorded efforts to have the spawn adhere to different substances and to vary the flow of water and the amount of light. Some eggs were sent to Mr. Clark, cautioning him not to throw away any eggs, "no matter how badly they looked on the outside, how much fungus there might be there, nor how foul an odor might arise from them." Mr. Clark said, page 13, that he found the eggs as I had stated, and about 15 to 20 per cent. of them were good. I had said that we could hatch 40 to 50 per cent. in our jars. Mr. Bissell raised the question of light, and said: "If the light affects the

eggs of the smelt, would not the light affect them in their natural condition in a small stream?" To-day I can only answer this very sensible question by saying that sunlight will kill our eggs in the jars, and in this year of our Lord, 1894, I have seen smelt eggs hatch on stones in a rapid stream with not over two inches of water over them, and in the brightest of sunshine. This is one of the problems that we have not solved.

In the Report of our Society for 1887, page 11, will be found my item on smelt hatching under the title of "Work at Cold Spring Harbor." In this it is stated that "out of 4,000,000 eggs we hatched and planted 2,000,000 fry, or about 50 per cent., which is as good as we have ever done." I added that "the little smelt carries a great many eggs for its size, from 30,000 to 60,000 or perhaps more, and from 100 ripe females of good size, probably 5,000,000 could be obtained." In the reports of the U. S. and N. Y. Fishery Commissions the foregoing statements have been embodied, the American Fisheries Society getting the first reports because their meetings were held earlier in the season than the other reports were called for

Until last year we stripped the fish and impregnated the eggs by hand, but holding our fish in the hatching troughs until ripe we found that many females had spawned in the troughs and also that the percentage of impregnation was very high and that they hatched well. This year we gathered all our eggs from the troughs, passed them through wire screens to separate them and put them in the jars. At intervals of two or three days or whenever the eggs seemed inclined to gather in bunches we repeated the operation, gently forcing the eggs through the screens with the fingers, and after a few such screenings the "foot" seemed to be destroyed. This "foot" is a projection on the egg, which is shaped like the stem and bottom of a wine glass, and is the only point of adhesion which the egg of the smelt has;

there is no glutinous coating around the egg of the smelt that will enable it to adhere at any point, and the frequent breaking of the hold of this foot makes it powerless to adhere to other eggs or to any object, and leaves the eggs as free and clean as those of whitefish or shad, and enables the attendant to remove all bad eggs from the top, as is done with other eggs hatched in jars.

Last year I was greatly interested in the paper read by Prof. Jacob Reighard of the University of Michigan, "On the Handling of Adhesive Eggs," and of his use of corn starch to overcome the adhesive tendency in the eggs of pike-perch, and had thought of testing that method with smelt eggs, but they worked so well with a few siftings, that it did not seem necessary to try any other method. The eggs remained free and clean, with the exception of those in one jar, which were taken from the brook, that retained sand on some of them that would not permit the dead ones to rise.

A resume of my work in stocking a barren stream with smelts for the New York Fishery Commission will illustrate the value of such work in a manner that can only be shown when fry of any fish are placed in waters which did not contain them before. Adjoining the grounds of the Commission at Cold Spring Harbor, Long Island, is a short stream from the overflow of a mill pond. This stream is not over 600 feet long between the dam and salt water, at high tide, and is about 15 feet wide, with pools and shallows where the water ripples over pebbles and is not 2 inches deep. This stream I stocked with smelts in a small way in 1885, and it is now a fine smelt stream.

In that year, and for several years afterward, we bought live smelts from the Connetquot River,* a small stream rising in the center of Long Island, north of

*In the reports the printers have usually made this the Connecticut River, and this note is to warn them that the above spelling is correct.

Yaphank, and flowing into Great South Bay near Bellport. We paid ten cents each for the fish and would get two or three hundred smelts of different sizes and degrees of ripeness.

In 1890 we only bought 100 fish, as we had an offer of all we wanted without cost from Mr. H. Scudder, of Northport, only seven miles distant. Next year, or six years after the first small planting, we found that the smelts were running up our stream in numbers to make it worth while to try to get eggs from it, and we did.

This was the first proof that the little brook had been made a self-sustaining smelt stream, although we knew that a few fish had run up it in years before. The habit of the smelt to run up streams at night, and return to salt water before day, enables it to escape observation to a very great extent unless one is especially on the watch for its coming. The eggs are deposited on stones in the swift water, and never in the pools, where the flow is slower. They are hatched in bright sunshine, which will kill our eggs in the jars, and unless it may be a provision of nature to check the increase of this prolific fish by killing the eggs that chance to get the direct rays of the sun, and to have only those which lie on the shady side of stones come to life, I cannot understand why the sunlight is fatal in the jars. Perhaps we may solve this problem some day, but an inspection of the stones in the stream, where millions of eggs were laid this year, did not offer a solution to this question which, by the way, never came up until the hatching season was about half over. Next year we may observe the effect of the sun on the eggs in the stream more carefully; we know what it is in the jars.

Our plantings in this little stream were:

1885 - - -	100,000 fry.
1886 - - -	2,100,000 fry.
1887 - - -	2,000,000 fry.

*1888 - - -	1,000,000 fry.
1889 - - -	4,600,000 fry.
1890 - - -	3,950,000 fry.
	500,000 eggs sent away.
1891 - - -	7,400,000 fry.
1892 - - -	5,631,000 fry, and eggs sent away.
1893 - - -	5,722,000 fry.
1894 - -	22.603,000 fry.

Total planted 55,606,000 eggs and fry.

Until this year there was no demand for the fry, because it was not understood that the Commission could furnish smelts; but the demand increased with the supply, and outside of the 11,083,000 planted in Cold Spring Harbor there were two plants on the South Side, three in the tributaries of Peconic Bay, one in Westchester county, and seven plants at different points on Long Island Sound. These plants were all made on special applications to the Commissioners of Fisheries, and it pleased them to have them made, because it showed appreciation of their work in a field that was almost new.

The value of the smelt may be illustrated when we know that forty carloads were shipped to New York from New Brunswick this year, besides the supply from Maine, Rhode Island and other places. Long Island smelts do not now make a great figure in the market reports, but the plants of this year, which were of one million fry, in most cases, may work a change to the benefit of the fisherman and the consumer in a few years.

Our figures this year were:

Eggs taken - - - - - - -	31,708,000
Loss of eggs‡ - - - - - - -	9,105,000
Fry planted - - - - -	22,603,000

*The March blizzard this year, from 12th to 20th, prevented getting eggs.

‡This loss includes two million eggs lost by the clogging of a tube supplying two jars on the night of March 17.

The figures show that over 71 per cent. of the eggs taken produced fry, and the reports of a few years ago show that when we produced 50 per cent., and thought it good, Mr. Clark remarked that it was as good as might be done with adhesive eggs.

That we have made rapid strides in the work of smelt hatching is shown by the table giving our yearly plantings, where it will be found that of the 55,000,000 fry and eggs distributed in ten years almost half the number was sent out this spring. It should also be borne in mind that this great result was obtained from an insignificant stream that never contained smelts before—it was stocked by the New York State Fishery Commission.

COLD SPRING HARBOR, N. Y., May 10.

ADDRESS OF CAPT. COLLINS.

Mr. Chairman, Mr. Chamberlayne has alluded to my name in his paper, and I feel that I should make some comment upon it, especially as I represent the Commercial Fisheries Association. If the fishery interests, or industries, could do all that Mr. Chamberlayne has stated, they would be given a much better showing than they now have.

As a matter of fact, the commercial fishermen of this country always have had all they could do to maintain themselves and to earn a living. As a rule, fishermen are poor men, and always have been in every age and in every country. For this reason not only has it been the object of this country to foster sea fisheries in other days, but other nations have done likewise.

As opposed to what Mr. Chamberlayne has said, permit me to state that the so-called fish protective associations of this country largely represent the money, brains and influence of this great land. Look around you and see! Here are men of wealth; men who represent the press; men whose moneyed interests count ten to one against what the fishermen have.

If the fishermen have organized for the purpose of gathering data concerning the fisheries—a fact which no one will deny—who can find fault with it? If we are to judge correctly of these matters, we must have a basis of fact to rest conclusions upon.

I deny that it has been in the power of the fishermen to do what it is claimed they have done. Such papers as these are wrong. They do great injustice to industries which help this country.

I ask any man here if these fisheries have been conducted illegally. Mr. Chamberlayne has said that

the fishermen find it easier to secure the enactment of laws favorable to fishing than it is to meet harsh measures in court, and be compelled to defend themselves against unwise laws which have been made. Of course they do, if that is possible, and so would anyone.

Now, underlying all this question is the claim that sea fish are growing scarce. I have had an experience in sea fisheries going back to 1849. I know something of them from actual observation, and am prepared to say that there have been fluctuations in the abundance of many species of our fishes since the beginning of the history of this country. This cannot be controverted. Take the mackerel, for instance. In 1671—more than 220 years ago—the General Court of Massachusetts passed a law restricting the mackerel fishery, because it was felt there was danger of extermination of the species. You can put your own estimate on this. But it is well known that the entire catch of New England at that time did not amount to so much as one vessel might take now in a single prosperous season. Since the beginning of the mackerel fishery, as an important commercial industry in the early part of this century, there have been as great fluctuations of abundance as have ever been known to occur in the history of this fish. In 1831 the ocean off the New England coast was filled with mackerel, and the catch was very great. At that time fishing for mackerel was carried on almost exclusively with hook and line. A few drag seines and gill nets were used along the coast, but the catch in these was unimportant. There were no purse-seines then in use for catching mackerel. Nevertheless, mackerel began to decline in abundance immediately after this great yield, and in 1841 the catch amounted to only a little more than 50,000 barrels as against about 400,000 barrels ten years previously. They reached low water in abundance in 1841. Then the

scale began to rise, though somewhat irregularly ; and about 1850 mackerel were plenty again.

Now, let me say right here, that the introduction of the purse-seine in the mackerel fishery began in 1839, and about 1860 it was pretty generally used. But in 1884, forty-five years after the adoption of the purse-seine as an implement for the capture of mackerel, and a quarter of a century after it was almost universally used by mackerel fishermen, mackerel were as abundant off the coast of New England as they have ever been at any time since the settlement of the country. Who will believe that the purse-seine is instrumental in causing a decrease of the abundance of this fish when it had no such influence during the twenty-five years ending in 1884.

Now, immediately after this great plentifulness in 1884, history began to repeat itself. There was a decline the next year in the capture of mackerel. The yield of salt mackerel in New England for 1890, according to the report of the Boston Fish Bureau, was between nineteen and twenty thousand barrels. Then it reached its low water mark again. And one reason that the mark was so low is ascribable to the small number of vessels engaged in the fishery as compared with 1841, when a large majority of the fishing fleet of New England was thus employed. Well, sir, starting from that low point there has been a gradual upward tendency in the yield of the mackerel fishery, and last year the New England catch of salt mackerel, according to the authority I have quoted, exceeded 55,000 barrels, notwithstanding a less number of vessels was employed than in 1889, when the catch was not quite two-fifths as great. The catch last year was almost three times as much as it was in 1890. I do not know what success this year may bring. I am not a prophet, nor the son of a prophet, but think one would not risk his reputation very much if he took upon himself the responsibility of

predicting that within the next decade there will be as great an abundance of mackerel as we have ever seen. If so, it will be another repetition of history, for all of you are familiar with the fluctuations of the mackerel fishery.

Now permit me to speak of a few other species. Facts are stubborn things to deal with, but they cannot be ignored. Fulton market stands in evidence this spring to show that bluefish were never more abundant within the memory of man than they now are. The vessels that have come into Fulton slip this spring were loaded to their scuppers with bluefish. The market has been so over-stocked that there has been scarcely any sale for them. The bluefish is one of the best food species in the world, and it has been selling at about one and one and a-half cents per pound. These fish were taken with hook and line. It is assumed that nothing will be said against that method of fishing.

In a hearing before a joint committee of the New Jersey Legislature a few weeks ago, the gentlemen who represented some of the real estate interests on the coast, while conceding that bluefish were abundant at sea a few miles from the shore, complained because they did not come in nearer to the land. How can that be rectified? Will anybody suggest how it is possible to influence bluefish to move out of the route they have chosen for themselves?

The Commissioner of Fisheries of the United States, in presenting his paper yesterday, made some statements relating to the decrease and increase of various species of food fish. These statements showed that the catch of bluefish in 1892 as compared with 1880 indicated an increase of 1,250,128 pounds. I concede that these figures are estimates to a considerable degree, so far as 1892 is concerned—as are the figures showing a decrease in the catch of certain species of fish—for the reason that there has been no investigation of the fisheries of

the Gulf States and South Atlantic coast since statistics were obtained for 1890, while the statistical enquiries covering other sections of the Atlantic coast I believe have not been complete so far as including all kinds of fish is concerned. The figures presented, however, showed an increase in the catch of mullet of 14,512,890 pounds ; of sea-bass, 5,785,903 pounds, and of squeteague or weakfish, 6,876,893 pounds.

There was shown to have been a decrease in the catch of cod of 26, 403,539 pounds. I wish to say something about this. I feel that I can speak with some authority in regard to the matter, since, in 1879 and 1880, I was engaged in the statistical canvas of the coast fisheries of New England where the cod fishery is most extensively carried on, and in more recent years, I have had charge of the work of collecting and compiling fishery statistics for the government.

In recent years the market fishery of New England has grown enormously. The finest vessels of the fishing fleet engage in this industry from Boston, Gloucester, Portland and other ports. The fishery is at its height in winter and a large portion of the fish taken are haddock. At Provincetown, where there used to be a large fleet engaged in cod fishing on the Grand Bank of Newfoundland, that industry has to a large extent been superceded by this market fishery, which has been found more profitable than catching cod on distant banks. As a result of this change in fishery, the decline in the catch of cod has been more than counterbalanced by the increase in the take of haddock and allied species, by the market vessels Thus, the combined catch of cod, haddock, and other species of the cod family is probably greater to-day, or was greater in 1892 than it was in 1880.

In this connection, it is pertinent to remark, as bearing upon the question of the increase or decrease of sea fish, that, twenty-five or thirty years ago, the taking of

haddock on George's Bank was only an incident of the fishery. I was there and can speak by the card. The market fishery for haddock on George's Bank began about 18 years ago, and a friend of mine inaugurated the fishery. He made the first haddock trip to George's. At that time a fare of thirty or forty thousand pounds of fish was considered a good catch, and fifty thousand pounds was something extraordinary. The fish taken were mostly haddock, though large quantities of cod were caught. Last March a considerable number of the market schooners which sell their catch at Boston, brought in fares averaging upward of 100,000 pounds of fish each. And in one instance the schooner *Indiana* landed a fare— the result of three days fishing— of 132,200 pounds. Think of it! Sixty-five tons of fish taken in three days fishing in the month of March!

Now, these are facts. I have no desire to give anything else to this Society, or to anyone else, especially the honorable gentlemen who are connected with the Pennsylvania Fish Protective Association. But I have felt impelled to cite these instances, in view of what Mr. Chamberlayne has said

Now, sir, I do not know how other gentlemen may view this matter, but I contend the fishermen have a right to organize for the collection and dissemination of knowledge concerning the industry in which they are engaged. If they do that work faithfully, as I believe they will, they will add not only to the knowledge we now have, and help to produce the most accurate fisheries statistics, but they should be able to add vastly to the sum of our scientific knowledge. And why not? Where does the United States Fish Commission get its statistics, and its information concerning fisheries? From the fishermen. Where can the state fish commissions secure statistics, if they gather them, except from the fishermen?

Now, sir, there is this difference between the methods heretofore adopted and the scheme proposed by the fishermen for collecting statistics and information, and I do not make any secret of it. The plan of the Commercial Fisheries Association is to place a blank in the hands of every man who sails a vessel or boat, or who operates a pound net, gill net, or other forms of fishing apparatus. Upon these blanks a correct daily record of the catch will be made, at the time, when the facts can be put down with exactness, and statements will not be given from memory, six months to five years after the fish are caught, as has been the case heretofore. It is the purpose of this organization to impress upon every fisherman connected with it the importance and necessity of recording the facts with the utmost fidelity and accuracy. We want the truth, the whole truth and nothing but the truth. Who can ask more than this? The gentlemen who are interested in fish protection, and who desire a basis upon which to base honest conclusions, need the truth also. And I say that in doing this work, if it is honestly and intelligently done, the fishermen will act on correct principles. We must have the truth; nothing else will suffice to settle this question; and we propose to nail our flag to the mast on that issue. The fishermen propose to stand on the rock of truth, and I ask any gentleman here if he is content to stand elsewhere in this controversy?

My friend, Mr. Whitaker, has stated that it is proposed to begin "a campaign of education." I am glad of it. That is in line with what the fishermen intend to do. Their only safety lies in the education of the public concerning fish and fisheries. And who will protest against it? The United States Fish Commission has been doing this kind of work for twenty-three years, and it has received the commendation of the whole world for what it has done in that direction. The various state fish commissions will probably be

interested in this movement. And I say to you that the fishermen are willing to join in any honest effort to educate the public regarding the industries in which they are engaged. And who can object if they put up their money for this purpose? This work will not be done in the dark, nor under a bushel. It will not be done for any improper motive; it will be done for the purpose of gathering reliable facts, such facts as everybody can use to base just conclusions upon.

Now, sir, I have nothing to say against angling. Many of my friends are anglers, as you know. I recognize the fact that among the anglers of this country are men of the highest merit and the greatest ability. I also feel that any man who is interested in increasing the supply of food fish, whether he is an angler or a fish culturist, is engaged in a worthy work. But we are all human and we are liable to err in our judgment, under certain circumstances. Therefore, in behalf of the commercial fishery industries of this country, and having in view their magnitude, and the vast importance to the American public of their continuance, I say that it is well to be cautious about restricting coast and sea fishing, and it is better to be sure we are right before we go ahead. The fishing interests of this country have a special claim to the consideration of the American public, and a claim upon every man who in any way is interested in fish or fishing.

It is unnecessary for me to say to this audience that fishing was the first industry of the Western World. But for the deeds of the fishermen in Washington's army, we might never have gained the liberties we now enjoy. This is a matter of history, and should be familiar to everyone.

Millions of capital are invested in these industries, and thousands of men, women and children, depend upon them for their bread. The prosecution of the fisheries is hard enough at the best, as I know by dear

bought experiencc. All these things should be taken into consideration before we reach conclusions, or advise legislative action, which may hamper the fisheries and prevent the successful continuance of industries of great importance to this country. Speaking for myself, I want to say that before I will do a single thing in this connection that my conscience would reprove me for, I will cut off my right hand.

This is not my first appearance in public in connection with the fisheries. Nearly everyone here knows me; knows where I have been and what I have done. My feelings regarding these questions are the same to-day that they were when I was connected with the U. S. Fish Commission, and had the responsibility of gathering statistics and other data relating to the fisheries of the entire country. I am not a fanatic, as you might be led to believe, but now as then am willing to abide by the truth. and am open to conviction. I think that every honest and fair-minded man should be willing to meet these questions upon a basis of ascertained facts, and compromise on that basis if compromise is necessary.

HAS OUR CIVILIZAITON SUFFICIENT INSURANCE AGAINST FAMINE?

We live in an age of marvels, in a world of our own creation, with no land marks to guide, no beacon of past experience to adequately illumine our pathway. Invention follows invention, and discovery, discovery, each opening an immeasurable field for the effort of mankind, with the assurance of a corresponding addition to its happiness and well being. Luxuries undreamt of by our forefathers, possessed at first by the wealthy few, become the comforts of the many, and then in turn the necessities of all. The marvels of yesterday become the commonplaces of to-day, and in constant succession, new wonders, new triumphs encourage hopes almost beyond conception. Natural forces are revealed to be forthwith harnessed to our service and the industrial capacity of a hamlet is expanded to that of a city. Magazines of natural wealth, hitherto unseen or undisturbed, have been broken upon and the accumulated treasure of forgotten ages squandered without thought of the needs of any but ourselves. Standing upon the pinnacle of achievement and surveying a century's advance, we regard its nearing successor as fraught with triumphs as magnificent, with conquests as abiding as those which have forever glorified our own. Yet the powers of the human intellect have a limit upon whose verge we may not know when we stand, but up to its attainment await in hopeful confidence the development of resources that may ever be elusive or imaginary. Without regard, therefore, to the dimly foreshadowed possibilities of a doubtful future it behooves us to make the utmost of that which we have and with patient and

prolonged labor to accomplish results that perhaps cannot otherwise be attained.

Upon the land, man's dominion is supreme; its face, where fairest, he may scar, ravage and make bare, that stranger winds may come and wither it into an abiding desolation ; he may reclothe his desert with its raiment of verdure, and if so willed, bend to his purpose every form of its animal and vegetable life. But need we longer say with Byron in his noble apostrophe to the ocean ?

> Man marks the earth with ruin—
> His control stops with thy shore.

We who girdle its bed with thought-flashing cables, who in floating palaces skim its seas with birdlike speed and grace, who sound its remotest depths and reveal its uttermost secrets, we who do all this should be as little of the poet's mind as we are of his generation. Moreover the ruin of which he speaks has not stopped with the ocean's shore ; beyond that dread-bound man has ravaged and despoiled, its harvests he has withered, and the blight of his hand lies heavier upon the sea than upon the land. For upon the scarred earth he has spread the cloak of his repentance, into her wounds he has poured the balm of peace, and with careful nurture and thoughtful ministration he brings her back to gladness and beauty. The sea is still the object of his rapacity, his destruction is constant, his warfare merciless and he sees not in his blind greed the shadow of the coming desolation.

Upon the land bitter experience has taught us that conservation is better than reparation and dumb indeed need we be if our lesson has revealed not only a new field for its application, but also the means of achievement. To obtain dominion over the dwellers of the sea, to set apart the available and destroy the harmful, to make the sea our preserve as we have the land our pasture, this should be our purpose, our ultimate hope.

Lost in the gloom of a vast antiquity, there must once have been a benighted savage who from the wild sea grasses about him chose that of the most promise. Its cultivation maintained with interrupted and oft-flagging effort, and prolonged through innumerable generations, resulted in the perfection of our first cereal, the barley of the present day. That pioneer agriculturist opened an immense field to the labors of his posterity, but only inferior thereto is that we may mark out for the generations that we hope are to follow in our footsteps. Unlike the land, the ocean has no absolute deserts, nor bears it a mere surface film of life, but in all its varying depths and in every portion of its vast waters it teems with animated creatures. Even where man has bereft it of its choicest treasure, its nursery remains, ready like the rich grasses of a far rolling prairie, to foster renewed swarms into being.

Agriculture is the development of an immeasurable antiquity, but with a larger intelligence, sustained with greater constancy of effort operating through a far less period, we may make pisciculture its handmaid, the twin dependence of that perfected generation to whom in vastly increased number we may hope is to descend the heritage of a gladder and a fairer earth. Generation by generation our social structure assumes greater harmony and efficiency of action, for within it there is a constantly increasing diffusion of the comforts, the luxuries and the knowledge of life, each and all tending to an ultimate equalization and balance of its various parts. This development of society, the most remarkable feature of our age, is the result of the greater division of its labor occasioned by the increased capacity of its food producers. No complex social structure, no great diversity of industry or amassing of wealth is possible in a community the time and energy of whose members is mainly absorbed in the mere production of food. In all civilized countries there has been within the last

century a far greater increase in the industrial than in the agricultural population, as is plainly shown in the enormous growth of cities and towns, a relative growth so steady and constant that it necessarily reflects a corresponding development of agricultural skill or capacity. It is this surplus of the food producer that has at every period of the world's history been the measure of its progress and prosperity, and the index of its accumulated wealth. For the labor of the agriculturist, if limited to his own needs, disappears with the enforced consumption of the product; it is only the excess that supports industries whereof the results assume permanence and constitute national wealth.

Among the innumerable forms of organic life there is everywhere a relentless struggle for the means of subsistence. Alike in the meadow and the forest, the rill and the river, the pond and the sea, there is neither blade of grass, nor towering tree, no bird, no insect, no walking or swimming creature whose existence does not imply the wresting of sustenance from the many that have perished Even man, whose increase involves the destruction of so much that is below him in the scale of being, needs himself to bend to the mere acquirement of food the weight of his overmastering energy. Famine has ever been the scourge of his race, the spur of his industry and the dread school of his forethought and frugality. Equally with the humblest organism he finds his proper nutrition the object of his main endeavor, the occasion of a struggle whereof the gravity deepens with the coming and the going of the generations. For even with the utmost advance in scientific farming as indicated by the possibilities of agricultural bacteriology, there is reason to presume

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To the reckless destruction of forests is largely attributed the famines of India and China, the aridity of much of Spain and Italy, and a measure of the depopulation of Asia Minor, and other portions of the East. The renewel of denuded areas in France and India has already accomplished remarkable results, which, however, are of little moment compared with the promise of the future.

that population will in the future tend equally as in the past, to press upon the means of subsistence.

The so-called intensive farming of the future which by some optimists it is hoped will adapt itself to the requirements of our industrious posterity, is very exhaustive, requiring constant replacement of materials abundantly absorbed. Modern tillage, although it has not reached the "intensive" stage is so extravagant in its demands that the earth is already practically stripped of its guano deposits and its remaining formations of nitre, mineral phosphates, etc., cannot very long continue to contribute to the needs of an insatiable soil. Even the fullest utilization of the sewage of our cities will suffice for the enrichment of but a comparatively limited area, nor can we adopt the reparative methods of the Chinese without a very material sacrifice of the comforts and decencies of our civilization. We who stand in its fullest effulgence, and accept it as the ordinary and natural outcome of our lives need to occasionally avert our eyes from its glare and regard the shadows from which we have emerged.

In the world's history the problem of the subsistence of its greatest aggregations of humanity has been generally solved by the various agencies of war, pestilence and famine. The duration of no agricultural nation of antiquity of which we have record was sufficient to evolve a distinct civilization, save those that occupied the valleys of the Euphrates and the Nile. Century after century for thousands of years the annual inundation of their vast bottom lands yielded the Assyrians and Egyptians a stream of sustenance as steady and constant in flow as that of the fluvial arteries whose pulsations were the nation's life. Elsewhere, primitive methods of tillage were insufficient to sustain

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England, where scientific farming most generally prevails, absorbs nearly the whole of the Chilian nitre production, and receives the greater part of our export of fertilizing material, now amounting in monthly value to nearly $400,000

large populations, and the growth of agricultural knowledge, while it prolonged, could not render permanent the food capacity of the soil. Nor has modern science devised means of compensation that are steady and lasting, although there is a possibility that by the culture of nitrifying bacteria, the requisite supplies may be obtained from the nitrogen of the atmosphere. The problem is one of gravity, for not only is the soil divested of its nutritive salts by the growing plant, but every drop of rain that finds its way to the nearest water course bears to the all-devouring sea a portion of the treasure that man seems impotent to conserve. To that ravening sea, therefore, the apparent bourne of all terrene substance, must he have ultimate recourse ; there must he regain some measure of that of which he is incessantly drained.

It is a century since Malthus startled a blissful world into the consciousness of an impending calamity, and, although the baleful spectre that he then invoked has receded before the advance of an ever-expanding knowledge, it yet lurks in the shadows of a fateful future. It was his contention, as it is that of many thoughtful men, that the steady increase of population tends to the exhaustion of its alimentary resources, and that the utmost development of its limited area of tillable land would ultimately be inadequate to satisfy the demands upon it. Apart from the accomplishments of modern science, there were certain factors that he disregarded, and the catastrophe was therefore made to appear of woeful imminence, but with its relegation to posterity public interest subsided. However remote may be the day that dawns upon a famishing and a diminishing world, there can be but little doubt that its substantial deprivation of animal food is a near contingency. In the dietary of the great bulk of its population it already has no place, and but rarely in the greater portion of the remainder. Meat affords a stimulating

food, and seems to be the fit and proper aliment of a nervous and energetic people to whose greater vehemence and combativeness do those succumb of whose sustenance it forms no part. Nevertheless, fish will need to become the only resource of posterity against the inevitable deficiency of the more potent aliment, a lack that will be hastened by the diversion of grazing lands to the food requirements of an increased population.

Meanwhile, like the overspreading of pent up waters, wave upon wave of humanity is dispersed over the bosom of our fruitful earth whose utmost gifts are to be absorbed by the multitudes it calls into being. Where population has long been dense it is, under the fostering influences of civilization, becoming denser; the teeming throngs of Bengal and of further India undergo a steady increase. So also in Europe and our country the better condition of the poor first reflects itself in ampler nourishment and a constant increase in national wealth infers, even with a stationary population, a steady increase in food consumption. In South Africa formerly uncultivated or abandoned areas are filling up with fast multiplying tribes, who, in peaceful security, till the responsive soil with assiduous industry and care. No longer devastated by warlike clansmen who before British occupation or rule enslaved, slaughtered and devastated at will, the country promises to become the eventual support of millions where hitherto it has sustained hardly more than thousands. In temperate South America and Australia, as well as in Siberia and the Canadian Northwest, the occupation of the country

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I. It is the forceful fuel of an intense age; but with the fullest development of the world's resources and the diminished field for the exercise of its energy, the need of a flesh diet may cease with its loss. Although, apart from its greater proportion of water, fish has substantially the same composition as flesh, it lacks the stimulating power occasioned by the assimilation of animal tissue identical with our own.

Animal flesh, as is well known, when fed to animals, tends to their greater ferocity, but in Norway fish offal frequently becomes cattle fodder, and at the extremity of Cape Cod, within the memory of living men, a herd of cows were similarly fed without impairment of their gentleness or docility.

to its fullest extent by an agricultural people is simply a question of time. Thus will it ultimately happen that from the earth's lesser waters as well as from its all encompassing oceans, bordered everywhere by an industrious and enlightened population, will be drawn the deficiency of a burdened soil. That vast reservoir of marine life whose mere waste immeasurably exceeds the need of mankind can, under its wise and provident ministration, renew its treasures with unfailing abundance and thus to a remoter period may be deferred the apparition of gaunt famine stalking through a decaying world. To us the ocean is what the wide spreading prairie was to the Indian hunter, a free field for the exercise of indiscriminate slaughter, destruction and waste, but henceforward it is to be regarded as the common possession of mankind whereof the advantage of the individual is to be subordinate to that of the race. The code that will administer, conserve and apportion its benefits may be like that governing mining and irrigating industries—the growth of time—but the world will yet co-operate in a harmonious development and distribution of its common resources. The science of water farming will absorb a material share of its effort and talent, and make of the ocean a field for the maintenance, development and improvement of that which is of value and the elimination of that which is harmful. Our fisheries may not yield upon the invested capital a greater return than that of the farming interest, and the marine food producer contribute no more to the common alimentary stock than the average agriculturist. The vessels and apparatus employed are costly, and their destruction or impairment, and the loss, entire or partial, of the crew is an abiding contingency. In this respect we may be likened to our primitive ancestors, who ventured into the remote wilderness upon precarious

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II. The well doing of the humble ryot moreover enabling him to eat two meals a day where formerly he ate but one.

expeditions resulting sometimes in the killing of the urus or wild boar and sometimes themselves. Both of these animals, prototypes of our cattle and swine, were domesticated by some discerning savage whose more certain possession of adequate subsistence insured the elevation of his descendants in the scale of being. With the proper exercise of patience and skill, and the assured acquirement of due knowledge, we will cease to need to wander in remote and storm-tossed seas for fish we can secure in safety and abundance at our doors. The possibilities of fish culture are boundless, and their expression may awaken the same measure of incredulity as was occasioned twenty-five years ago by the preliminary efforts of the Fish Commissioners to stock the Connecticut river with shad. Yet a few seasons later the resulting abundance was so extraordinary that the erstwhile scornful fishermen begged the Commissioners to desist, urging that it was useless to hatch fish beyond the absorbtive capacity of the markets. Refrigerating appliances and improved facilities of transport, however, widened the market, and more effective appliances of capture soon enabled the rapacious fishermen to change the surplus into a lamentable deficiency.

A full recognition of the plasticity of all organisms, of the readiness with which their form, structure and habits adapt themselves to external influences, and are thus altered for the better or the worse, is one of the great developments of our century. A dim appreciation of the truth has been discerned and acted upon from time immemorial, but until the last generation no adequate conception of its possibilities dawned upon the minds of men. What the intelligent breeder has done we all know. With cattle it has been said that an ideal form chalked upon a wall, by patient effort and skill, by an acutely discriminating selection and avoidance of all but imperceptible divergencies, has resulted

in the attainment of the projected form. In one direction an endeavor to so alter and adapt the bony frame-work as to enable it to sustain the utmost possible amount of finely marbled beef has given us our massive short horns and Herefords; in another we have the small and graceful Ayrshire or Jersey so modelled as to give the largest development of udder; and to each and all there has likewise been imparted increased docility and gentleness. Our fruits and vegetables, under judicious and enlightened culture, have also undergone astonishing improvement, but the promise of the future is far greater than the accomplishment of the present. Having moulded animal and vegetable forms so nearly to our taste, it remains for us to attempt as much with our fish. Can we not also with painstaking endeavor so modify their habits, form and structure, in accordance with our desire? We certainly, from our success in similar lines of effort, lack no encouragement apart from what has already been accomplished, affording sufficient demonstration that fish lend themselves as readily to the breeder's skill as do other forms of life. Fish kept in so called tanks in India have been observed to become superior in size and of more brilliant coloring to those left in the rivers. This change has probably been effected by the selection of the smallest and most unattractive, leaving to the larger and more brilliantly colored the continuance of their kind. Carp, doubtless for the same reason, have assumed beauty of appearance and increase of size, and if considerations of table utility had prevailed over those of mere show, we would have possessed an uglier but more toothsome fish. Goldfish are a striking instance of what breeding and intercrossing can do, there being upwards of one hundred distinct varieties, all apparently evolved from a common dark colored stock. The various splendid colors, the diversity of form and other peculiarities have been developed by careful selections, and the persistence

of some characteristics point to a culture prosecuted from a remote period of time. Moreover, the ancient Romans practicised the art with success. The famous pro-consul Lucullus bred so great a variety of peculiar fish that his stock was sold for $150,000 of our money, and under the empire choice breeds were conserved by the wealthy with the same jealous care that a modern fancier bestows upon a rare strain of fowls.

Until the present century the improvement of our domestic cattle was due to what was in large measure unconscious agency. In slaughtering, the best would be reserved, the most abundant milker would be longest spared the butcher's knife, and so bearing a larger progeny would tend to the displacement of inferior breeds. Even this crude and unintelligent mode of improvement we have not applied to our fish, but select the largest and best and leave to the poorest the propagation of their kind. Once a year the ancient Incas of Peru held a great hunt at which the best animals were spared and only the inferior were killed. The old Scotch nobility pursuing, it is so said, the contrary method, despatched the noblest stags and largest does and found themselves the ultimate possessors of an impoverished and degenerated stock. Market fishermen cannot be expected to sacrifice immediate for ultimate gain; their need is pressing; they have families to support; and relentless competition necessitates their destructive methods. Avenues of ordinary and common human effort that are open to all become crowded to the limit of individual subsistence, and of such exigency selfishness and rapacity is the inevitable outcome, the contrary manifestation being at variance with human nature. Legislation is inoperative, its enforcement being difficut and unsustained by public sentiment. Hence, under the present system the exhaustion of our fisheries is unavoidable, and the only apparent alternative is State ownership and operation of all appliances of

wholesale capture, whether fixed or floating, in land or off shore waters within three miles of the coast. Only by the removal of all opportunity of individual enrichment at its expense can the community adequately protect itself, and the administration of its resources must therefore be in its own hands. With the careful and provident conduct of our fisheries, by intelligent and responsible agents, supply will be better adapted to demand, the terrible destruction of immature fish will cease, and a sufficiency of spawners be permitted access to their breeding places. No longer controlled by the ignorant and reckless, thoughtful observation will constantly tend to a wiser and more judicious cultivation and to the ultimate adoption of methods of scientific intercrossing and breeding.

Sustained by as keen an observation and discrimination of varieties of developement, and with the possession of the requisite means and appliances, the successful breeding of fish ought to be of speedier accomplishment than has been that of our domestic animals. For the greater fecundity of fish gives a far larger range of selection, and their early maturity a more frequent means of its exercise. These advantages may possibly be offset by deficient opportunity of observation and comparison that fish afford even in confinement. But with due facilities, there can be no question as to the attainment of results amply justifying whatever of time, labor or care the effort may involve.

Among the ancient Romans the breeding of fish was a pastime as well as a useful occupation, and with the wealthy a costly indulgence, initiated at an equivalent of hundreds of thousands of dollars of our money. Their vivaria were a great advance upon the piscina or ordinary fish ponds, being walled with marble tiles,

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III. The Inca system of state ownership and administration of useful *ferœ naturæ* seems with due modification to be the only one adapted to the proper conservation of our fisheries.

and having cemented bottoms, or else hewn out of the solid rock, and deepening at their further extremity into a cool and shaded grotto, to which the finny flock could retire in comfort and repose. The site adjoined the sea, and the form of the excavation was so designed as to insure a ready circulation of the contained water, its discharge and admission being effected by canals leading to opposite ends. Its constant freshness and purity was further maintained by the planting of sea weeds, rocks and stones bearing algae being scattered upon the bottom, thus anticipating the principle of the modern aquarium. The Roman culturists devoted their efforts to the propagation of fish attractive in color or extravagant in form and appearance. Most of their bizarre and fanciful productions were probably hybrids, and the enormous prices at which some of the collections were sold indicate a widely diffused appreciation of the art.

The possession by our rich of similar tastes, and their maintenance of marine aquaria as accessories to their sea-side villas, even to the displacement of breeding kennels and stables, would be of no prejudice to them and of probable public advantage. With activities quickened by the sense of exercise in virgin fields, and directed with intelligence and discrimination, the accomplishment of the modern culturist, if not so startling, would undoubtedly be of more value. Not only would such aquaria afford their wealthy supporters amusement and instruction, and possibly material profit, but tend also to further the science of marine biology now lagging in slow progression behind its fellows. Their interest, and also that of the community, needs, however, to be stimulated by the establishment of a public marine observatory, with ample appointments, and constructed upon an extensive scale. Such an aquarium should be under the constant care and observation of men of learning and acuteness, who would devote their knowledge and acquirements to the study and useful

development of marine forms, and also impart instruction to those qualified to learn. In short, an amply equipped college of biology, pisciculture and kindred branches of study, should be established upon the most liberal scale in a locality the natural advantages of which would insure its most economical construction and maintenance. Among the various branches of practicable effort that such an institution would facilitate may be mentioned the acquirement of knowledge as to the habits, mode of spawning of deep sea fishes, and also the acclimatization of edible fish of warmer waters. The elimination of the migratory instinct in the land-locked salmon of Maine, in the Canadian Winninnish, and also in the fresh water smelt of our own and of other lands, suggests another. During the first third of the present century the streams running into Lake Ontario swarmed in their season with myriads of salmon, farmers pitch-forked them upon the banks and sometimes at night their teams would kill them at the fords, the frightened horses plunging through dense masses crowding in darkness over the shallows. The choking of the streams with nets soon made the salmon a reminiscence, and to this day it is disputed whether they journeyed from the deeps of the far distant sea, stemming the swift current and swifter rapids of the mighty St. Lawrence, or whether they were residents of the great lake itself. We know, however, that the migratory instinct has become dormant in many anadromous fish, and there is reason to believe that their permanent adaptation to fresh water has been effected by natural agencies operating through a brief period.

If the swarming menhadden of our coast could be gradually replaced by a variety in which the wandering impulse was absent much would be gained, nor need it seem visionary to attempt its ultimate development into a valuable food fish by the constant addition of improved varieties obtained under culture. Although

we would need to bequeath its accomplishment to posterity, its initiation is commendable; for, apart from the enlarged conception of duty imposed by the enlightenment of our age, the stream of accruing advantage, at first imperceptible, would steadily broaden to its full measure of beneficence. Nature does not advance "per saltum." Neither the animal or fish breeder can hope to develop marked deviations from existing varieties save with assiduous care and prolonged effort, and the highest intelligence devoted to that end is certain of reward. Our splendid civilization is based upon the humble beginnings of remote ancestors and enlarged by the intermittent labors of innumerable generations, the accumulated results of which it is ours to enjoy. That perfected stage that is perhaps to be the heritage of our posterity might have been the present, if each generation of even our own era had been endowed with a sense of the duty that it becomes us to exercise.

It is by some maintained that the world's wheat crop of 1893 was inadequate, but if the shortage should be sufficient to advance prices, the crop of 1894 will be that of an increased acreage. If a century or more hence a deficiency should occur with the utmost development of the earth's agricultural resources, a second year of scanty production, in the absence of an

IV. Invariably by friend and enemy alike the English are described as the fiercest people in all Europe (Benvenuto Cellini calls them the English wild beasts) and this great physical power they owed to the profuse abundance in which they lived. A sturdy, high hearted race, sound in body and fierce in spirit, and furnished with thews and sinews which under the stimulus of "those great shins of beef" were the wonder of the age. Froudes' History England Vol. I, Chapter I. Their food consisteth principally in beef and such meat as the butcher selleth whereof the one findeth great store in the markets. Harrison's Description of England, page 282.

V. Despite local famines estimated to have carried off directly or indirected several millions, the population of India, according to the census of 1891, increasly 30,000,000 with the previous decade.

VI. Every year in some portion of the empire 50,000 or 60,000 of its people were gathered in an immense circle under the direction of some high official or of the Inca himself. Within this contracting cordon all harmful animals were destroyed, the male deer and the poorer wild sheep were slaughtered and the skins and meat distributed. The better sheep or Yicunae, after shearing, were let go, as were also the does and fawns. No one section was allowed to be hunted oftener than once in four years, and then only under government direction and supervision. See book I, Vol. I, Prescott's Conquest of Peru.

alternative harvest, might occasion direful results. Famines periodically visit China and yet in various parts of that kingdom fresh fish is so cheap as to sell at the same price as wheat, and but little below that of rice, the abundance resulting from a comparatively rude method of pond culture. It becomes our superior civilization to extend better and more scientific methods, not only to our own inland but also to our marine waters, to endeavor to regulate, govern and direct the produce of the larger areas as systematically as we would the smaller. Water farming implies some methods of marine to those of terrene culture, certainly the encouragement of the growth of that which is good and the repression of that which is noxious. The grazier whose herds suffer devastation receives a measure of protection from the community, which is extended as an obligation to its members, and the bounties offered for the destruction of beasts of prey should also be applied to that of marine food destroyers. A few years ago a company prosecuted with several steamers a fishery for sharks, dog-fish, porpoises and other destructive fish, their conversion into oil and guano promising a sufficient return. This expectation being disappointed, the fishery was abandoned, but its renewal under assurance of bounties should be thought worthy of encouragement. The extermination of predaceous fish is not to be hoped for but, inasmuch as man's consumption of edible varieties is but a fraction of that of their marine enemies, the abatement of the latter as a public advantage merits public support. The substantial elimination of the formerly plentiful halibut from the New England coast necessitating its pursuit even into Polar seas, demonstrates what can be effected by the constant capture of a predatory fish. With the persistent exertion of fostering care upon the one hand and steady repression on the other, he is not a vain prophet who would predict of our marine waters the

ultimate acquisition of an ample spoil lending itself with constant ease and unfailing abundance to the requirements of man. So may it be said that expansive seas, forming carefully cultivated and guarded preserves, teeming with alimentary treasures varying with the season, and in form and variety, in habit and structure best adapted to their needs, will be the assured possession of a near or a remote posterity unless civilization wanes and population declines.

Through the glass of eternal time slip slowly the century's closing sands, and the mighty stream of its effort seems to slacken and to dwindle with the ebbing of its years. During its course there has been a revelation of the earth's resources so startling to eyes long clouded by ignorance and doubt as to occasion an era of feverish development, of strained and intense exertion of the powers of our race, such as the world will probably never see again. Never before were the energies of mankind so expanded in magnificent achievement, and never before may it in sorrow be added were they exerted so wastefully and so destructively. The century to come will be more of conservation than of development, of maintenance rather than of progress, but still of continuous advance. To the reparation of our errors will be devoted much of the endeavor of our posterity, who will nevertheless honor us for much that we have accomplished for ourselves without thought of them as the ultimate beneficiaries. They will, however, hold those more worthy and deserving of a larger measure of gratitude who, with wise and provident foresight, sought provision for their eventual advantage and well being.

THE PRESSING NEED.

BY CHARLES F. CHAMBERLAYNE.

Mr. Chairman and Gentlemen:

Precisely in what way one not a fish culturist could add anything of value to your deliberations has been to me something of a puzzle. But in the confessed need for adequate restrictive legislation, law and fish culture join hands and the law makes, I am pleased to believe, a contribution of no mean value to our cause of fish preservation. In taking up, briefly, the question as how best to secure and enforce such legislation, the fact which first and most strongly impresses us is this: That while the necessity of restriction is adequately recognized, it is not always remembered what enormous changes time has wrought in the number, energy and resources of those whom it is thereby sought to restrain

The early enemy of fish preservation was the poacher. Now the poacher was usually a poor devil of small social, personal or financial standing. His ravages were limited in extent and usually for his personal eating, an offense against society which the state of his pocketbook frequently explained and almost excused. Even where his illegal fishing was done for market, the slow transportation of early days effectually restrained the extent of his depredations. With the law, the early poacher was not on easy, much less friendly, terms. To him it was invariably an enemy. He met it usually in the justice's court, and it meant merely fines and frequent imprisonments. Voluntarily, he never darkened the halls of legislation. All he asked of the law was to be let alone. Ostracised socially, not financially, wrong legally, early society felt itself amply able to protect

itself against the poacher. Whether it is also able adequately to protect itself against the poacher's successor in interest still remains to be demonstrated.

This gentleman of modern days is a radically different sort of person. He has money, intelligence, social position. The world's progress enables him to carry on the work of fish culture on a scale the poacher never could have dreamed. The power of steam and of an apparatus unequaled in destructive efficiency vastly augments his catch. Not even these keep pace with the broadening of his market. Swift freights carry fish to the great centres of population where steady and remunerative demand is certain. If these fail him, refrigeration gives him a continent for his wares. Canning offers him a chance to save much of the balance. He has much to work for and a good deal to work with.

All this means much to the situation. In the first place it gives the poacher's successor allies and supporters the poacher never could have had. The men who sell his fish or can them are bound to be his friends. If he is a good shipper he can count on the open or covert assistance of the transportation companies who profit by his freights. Hotel men and many others who want fish and are not particular where they come from and when they are caught ; the persons who sell nets, seines and other equipments ; those who buy, sell or are interested in the "by-products" of the fisheries in oil, guano, etc., these and many others stand together for the "Commercial Fishermen," as they are fond of calling themselves, their right to capture fish in any way and at all times.

More than this, the modern enemy of fish preservation has learned a fact the poacher never knew or perhaps, rather, was never able to avail himself of, and that is that killing fish by law making is easier, safer and better than killing fish by law breaking. Fish preservers no longer have law making to themselves. It was the sting of the

poacher's position that it was illegal. The "Commercial Fishermen" are in the market for laws benefitting their business, and against all laws restricting it. Their money gives them the aid of the purchasable lobby, the chance to ascertain and even occasionally to manufacture so-called "scientific opinion"; it purchases the skill of excellent counsel and possibly the rural part of the Legislature. Precisely the influence which makes good laws increasingly necessary, also makes it increasingly difficult to secure them.

As important and indeed necessary means to getting the legislation they want, the "Commercial Fishermen" are firmly and constantly using, with great perseverance and judgment, two important aids to any work: (1) Education; (2) Organization.

(1) The poacher never attempted to educate the public to his view of the situation. But the "Commercial Fishermen" appreciate that in a country where public opinion governs, the ultimate conditions of fish preservation will be determined by the general feeling of the people. A "Campaign of Education," therefore, is an essential part of the system. Listen, gentlemen, a moment, and you can hear the din of the work as it daily progresses. Every vehicle for reaching the public ear is carefully utilized. The press, the platform, the magazine, official, semi-official and private publications, are made the cover for reaching the people. The burden is always the same. The "theories" of fish preservers are computed by the so-called "facts" of the fishermen. Scientific statements, like those of Huxley and others, violently wrenched from their connection, and all necessary qualifications are forced to masquerade in novel and incongruous company to support propositions they really antagonize. Misleading and frequently false "statistics," "averages," etc., serve to give an apparently scientific flavor to the whole. That fish are not decreasing and indeed are indestructible; that every

fish caught is a fish gained and every fish saved is one lost to the community; that the fish destroyer is the "poor man's friend," and that fish preservation is the work of "dudes" and "sportsmen;" that the State and National Commissions, searching for truth from reliable sources, without bias or improper motive, are "theorists," while those who are endeavoring to support foregone conclusions, intensely profitable to themselves, by the best evidence they caught, are the "practical" men relying on demonstrated facts; that if "free fishing" were only ordained, the farmer would raise unlimited cotton, wheat and other crops with cheap fertilizers; the shoemaker get cheaper oil, and everyone be content and happy; such is the literature with which the combination is flooding our people and driving into their heads. All these constitute what these gentlemen call a "record," and is implicitly appealed to as such.

(2) This shrewd and careful, farseeing and persistent work can only be carried on by *organization.* An association of poachers would have been as unheard of as "Coxey's Army." But the "Commercial Fisheries" firmly believe in organization. No trade interest is better organized. To all the natural instincts of self interest urging union for mutual protection, is added that of a common danger—that of restrictive legislation. It was a significant circumstance to my mind that at the New York Conference at the Gerlach House, in December, 1893, while those in favor of fish preservation came largely as individuals, the pound fishermen, the net and twine men, the fertilizer men, the wholesale market men, the fish commission merchant, etc., usually appeared as the representatives of Associations—National, State or Local—and frequently by excellent counsel. The trust aggregation called the "United States Menhaden, Oil and Guano Association," under

intelligent management has carried on its work with a smoothness and completeness which may well serve as a model.

It covers the Atlantic States; it assesses itself liberally. Any attack on the interests of the Trusts in any State meets the entire force of the aggregation. The armory of so-called "facts" is judiciously drawn from.

"I once saw the Association at work at its best—in Washington—with its fertilizer allies, its net and twine allies, its wholesale fish market allies, its porgy oil friends, under the eye of the President of the Association. It was a beautiful piece of work. The co-operation of the Speaker of the House of Representatives had been secured by a pledge of support; a favorable committee had been appointed. At the hearing before this committee, witnesses, well drilled, well dressed, with neatly written rolls of so-called 'statistics,' were present in crowds. The press was utilized as usual, and marked copies were distributed where they would do good. Doubtful members were deluged with 'resolutions' from their constituents.

"They failed, indeed, but through no fault of theirs. They have a good memory for those who accomplish their defeat. They do not propose falling over the same stone twice. They were opposed by Doctor E. W. Gould, a Fish Commissioner of Maine, and Hon. A. E. Pillsbury, Attorney-General of Massachusetts. Mark the sequel.

"Last year Mr. Pillsbury, by far the ablest candidate in the field, offered himself for the Governorship of Massachusetts. The Association's counsel at Fall River carried every caucus of that city against him, and confessedly accomplished his defeat. When Dr. Gould's term as Fish Commissioner expired, the influence of the representatives of the Association succeeded in preventing his reappointment. Such work as this must in the

end succeed, unless opposed by equal skill and industry. It almost deserves to succeed

"It is unnecessary to defend the value of organization. No one can have seen and felt the splendid sense of honor in a body of disciplined troops, marching responsive to a single will; throwing against any enemy and in any direction the force of a united effort and failed to realize the immense superiority over any disorganized and indisciplined body of men. The latter may, individually, be equally brave and equally gallant, but there is a something, a power of co-ordination, an economy of effort, a something beyond the sum total of the individual units which makes it clear that no guerrillos, however spirited, can long contend against regular troops.

"A few days ago, this effort at organization on the part of those interested in fish destruction culminated in the formation of what is known as the "Commercial Fisheries Association," a national organization under the leadership of Capt. J. W. Collins, who thus happily has found a field of usefulness for his admitted talents without compromising his former associates of the United States Fish Commission. The fishing interest and all allied interests unite their money and influence against "unjust interference by those who erroneously assume that the methods of capture now employed tend to decrease the fish food supply."

Now what are we, on our side, doing to meet all this? Alas! but too little!

"We, on our part, have, strictly speaking, no inter-State co-ordination. If New York desires to protect the Great South Bay, for example, from the use of purse seines, the entire force in men, money and 'facts' of the opposition is available to fight her movement. But, on the other hand, the effort gets no men, money,

or 'facts' from New Jersey or Massachusetts, and the latter have, in their turn, to fear a united resistance to any attempt to protect their waters.

"The difficulty extends to the different sections of the State. Excellent organizations protect fish in many of our States, but seldom is there any general union of such organizations capable of delivering a blow with united strength and knowledge of all. In my own State, if Buzzard's Bay is attacked, she fights her own battle single handed, and renders no assistance to any other waters. In fact, our people would hardly know how or where to appeal for assistance. No section has adequate means of knowing who its friends are in other sections, or how a suitable influence can be applied by a non-resident legislator's constituents to quicken his zeal. Therefore, in matters of general legislation, the friends of fish usually do nothing to oppose bad legislation until it is too late. Just here organized devotion to a single end shows its superiority to spasmodic efforts, however spirited. The personal interest of the Commercial Fisherman is sufficiently intense to enable him to take time by the forelock.

DEFENSIVE ORGANIZATION NECESSARY.

"Fish preservation must organize, and its armory of weapons must be equally good as its cause is infinitely better. It is always easier to criticise than to create. But I venture a suggestion. Each State needs a federated organization of local clubs. These local clubs should still control and carry on the work in their respective fields.

"But for the general interest of the cause, every local club should have a representation in some central organization, proportionate to its membership; should contribute a stated sum per member to the treasury of the central organization, which should employ and

suitably pay counsel for responsibility for legislative results, and a general secretary to keep an accurate record of all those interested in fish and game preservation through the State, and employ the funds of the Central Association, as directed, for the distribution of appropriate literature adapted to the creation of a healthy public opinion on this very important subject. These central federations, in turn, should be entitled to membership, in certain established proportions, in an inter-state body which, either directly or through an executive committee, could direct in questions of national legislation or inter-State regulation and the general objects of the cause of fish culture and preservation. The expenses and salaries, if any, of such an inter-State Congress or Board of Management, should be paid from the State Central organizations represented.

"There is nothing novel about such an arrangement. It is merely carrying into fish culture the methods of political organization. The fact is hardly an objection. Whatever object depends on legislation is, in a sense, political, and the political organization has proved itself the most efficient means of uniting many minds and many mites to produce legislation, and that is what we are after.

"It may be further objected that such a plan implies work and raising money. Such is the fact. But when it is remembered what fish preservation means to us as a nation ; that cheap, healthful, and abundant food for the poor and all classes of the people ; the livelihood for hardy fishermen and boatmen ; the industrial prosperity of many sections of our States ; mental relaxation for the toiling workers of our cities in all the busy pursuits of our intense and intensifying daily life; that these and many other objects of vast importance, socially, morally and financially, are involved in preserving the bounties of nature for the enjoyment of the present and use of

the future, it is not too much to hope that, in spite of local jealousies, and even at some little expense, the broad-minded, free-handed American people will adequately support with their good will and a little money, a thorough, well considered and efficient plan of fish protection. In providing such a needed plan, and in carrying it out to a successful termination, no agency would be so adequate and so well calculated to attract immediate and wide-spread support as the honorable society that I have had the honor of addressing."

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American Fisheries Society

COMPILED FROM CASH BOOK AND ACCESSIBLE PUBLISHED ROLLS

By R. O. SWEENY, Sr.
TREASURER, 1894.

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Humphreys, Dr. E. W. Saulsbury, Md.
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Hand, Dr.
Huntington, L. D., New Rochelle, N. Y.
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Kimball, W. S., Rochester, N. Y.
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Long, Jas. Vomor, Pittsburg, Pa. '90.
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Ledyard, L. W. Resigned '88.
Ladd, W. W., Jr. Resigned '88.
Lyman, Col. T. Resigned '88.
Leeds, Thos. E.
Lampher, Geo. Resigned '88.
Mallory, Chas., Foot Burlington Slip, New York.
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Mather, Fred., Cold Spring Harbor, Suffolk Co., N. Y.
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Mills, Geo. T., Carson City, Nevada.
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Mann, H. H. '85.
Mayer, H. M. '86.
Michan, Wm. S. '95.
Nevin, James, Madison, Wis. (Wis. Fish Comm.)
O'Brin, Martin E., South Bend, Nebraska. '88
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Osborn, Hon. C. V., Dayton, Ohio. '90.
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Rufmeyer, L. M. '85.
Riley, C. V. '85.
Rice, H. J. '85.
Rogers, H. M. '88.
Rooseveldt, R. B. '88.
Rogers, W. H., Amherst, N. H. Deceased Spring of '94.
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Stelwagon, Wrightman, Philadelphia, Pa.
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Weeks, Seth, Cory, Erie Co., Pa.
West, Benjamin, Fulton Market, New York.
Whitaker, Herschel, 78 Moffat Building, Detroit, Mich.
Whitney, Sam'l, Katonah, N. Y.
Wilbur, E. H., *Forest and Stream*, New York.
Wilcox, Joseph, Media, Pa. '84.
Wilcox, W. A., 176 Atlantic Ave., Boston, Mass.
Willetts, J. C., Skaneatles, N. Y.
Williams, A. C., Chagrin Falls, Ohio. '88.
Wilmot, Sam'l, Ottowa, Dominion of Canada.
Wilson, J. Paul, Washington, D. C. (U. S. F. C.)
Wood, Benjamin, 25 Park Row, New York.
Woodruff, G. D., Sherman, Conn.
Worth, S. G. Washington, D. C. (U. S. F. C.)
Witherbee, W. C., Port Henry, Essex Co., N. Y.
Welshon, Geo. D., Pittsburg, Pa. '91.
Warren, C. C., Waterbury, Vt. (Fish Comm.)
Wilbur, H. O., Third St., below Race, Philadelphia, Pa.
Webb, W. Seward, 44th St. and Vanderbilt Ave., New York.
Ward, Dr. Samuel, Albany, N. Y. (Prest. New York Fish and Game Association.) Resigned Nov. 5. '93.
Whitaker, E. G., Mutual Life Building, New York.
Wallace, N., Farrington, Conn.
Yealden, J. New York. (Treas. Adirondac Reserve Ass'n.)
Zweighalt, S. 1323 Franklin St., Philadelphia, Pa.

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